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FOREWORD

Science and technology have enabled today's man a comfortable life, but, on the other hand,it took away his basic needs, of which mobility as the most important. A very fast pace of life, as well as the tendency of living in urban areas, has led to a reduction in the overall level of physical activity that include all population groups, from children to adults. At the same time, in a numerous sports and athletic activities, we are achieving top sports results. This paradox indicates the complexity of the problems pertaining to the field of sports, physical education and recreation and highlights the need for its continuous study.

Faculty of Sport and Physical Education,University of Nis, is organising for the 18-th time the international scientific conference "FIS Communications 2015". The conference aims at presenting and acquiring the latest knowledge in the field of sports science, physical education and recreation. The conference was held under the auspices of the Ministry of Education, Science and Technological Development of the Republic of Serbia.Our profound, years long experience in organizing the conference, has contributed to increased numbers of authors from different countries over the past few years. Also, each year the number of participating countries is growing.This year, the "FIS Communication 2015" has participants from 12 different countries. At the same time, there is a significant increase in the number of entries compared to previous conferences. As part of this year's "FIS Communication 2015" a total of 88 works were reported, of which, after the review process, 66 papers were accepted and approved for publication. We were pleased and honored to have been given the opportunity to publish three articlesfrom eminent scientist in their areas, so the total number of submitted papers was 69. Papers were presented in four sessions, depending on the topic, as follows: Sport; Physical Education; Exercising and Health; Corrective exercise, adapted physical training and sports rehabilitation.

Organizers of "FIS Communication 2015" are satisfied with the participation of established researchers, but also with the young ones who are making the first steps in scientific research. We hope that the participation of numerous domestic and foreign speakers and authors, as well as varied conference topics, will lead to the improvement of knowledge in the field of sport, physical education and sport recreation and to encourage and stimulate further cooperation and new creative efforts.

On behalf of the Organizing and Scientific Committee, I thank all the participants of "FIS Communication 2015", and especially to the authors who presented their papers, andactively participated in the conference. I expect that all the conclusions and statements from this scientific conference willcontribute to the advancement of the scientific and expertise thought in the area of sport, physical education and recreation. Moreover, the presented papers related to sport, physical education and recreation should encourage general public to launch specific measures for their improvement. Finally, I hope that the conference participants and readers of this proceedings will find interesting and entertaining information that will be useful in the future.

Chair of the Scientific Committee
Saša Pantelić, PhD, prof.

CONTENTS

Plenary Sesion

THE EFFECTS OF PHYSICAL ACTIVITY AND INACTIVITY ON THE MUSCULOSKELETAL SYSTEM IN OLD AGE

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UDC 053.9.796:611

Muscles and tendons show a remarkable plasticity in response to chronic loading, unloading and ageing. In recent unloading studies we showed that bed rest (BR) and unilateral lower limb suspension (ULLS) induce a significant decrease in muscle fibre length (-8% after 23 day ULLS and 9% after 35 day BR). At single fibre level, unloading causes a decrease in the cross sectional area (CSA), specific force (Po/CSA) and myosin concentration (MC) of both type 1 and 2A muscle fibres (Brocca et al. 2015). Concomitantly, tendon stiffness drastically decreased (30% after 23 days ULLS, De Boer et al., 2007). These changes are very similar to those found in ageing since both lower limb fibre length and tendon stiffness are reduced in older humans (Narici & Maganaris, 2007). However, the size of these changes (reduction in muscle volume and peak aerobic power) are greater in older individuals (Pisot et al 2015). With increased loading, these myotendinous changes are reversed (Reeves et al., 2006) but the speed of recovery is slower in older individuals (Pisot et al 2015). The rapid muscle remodeling produced by these experimental paradigms (occurring within 10 days of loading or unloading) seems regulated by changes in mechano-sensitive proteins such as focal adhesion kinase whose content and activity increase with loading (Flück et al., 1999) and decreases with unloading (De Boer et al., 2007).

Additional noteworthy observations on chronic inactivity are its consequences on glucose metabolism and neuromuscular integrity. Few days of inactivity (sitting or bed rest) are sufficient to induce insulin resistance (Knudsen et al. 2012; Pisot et al 2015) while 60 day of bed-rest induce alterations of the neuromuscular junction (Salanova et al. 2011). Similar changes are found in aging as older people tend to have lower levels of physical activity than young adults. However, it seems that maintaining an active lifestyle preserves neuromuscular function and prevents the age-related loss of motor units. Investigations currently in progress in our laboratory show that while older people and even more so older inactive people have marked signs of neuromuscular junction (NMJ) degeneration, older active and chronically active older individuals (master athletes) show little or no signs of NMJ degeneration.

The present findings provide strong evidence that chronic inactivity has profound effects on musculoskeletal and neuromuscular system integrity. These changes are associated with important alterations in insulin sensitivity and in NMJ integrity. On the other hand, regular physical activity not only restores muscle mass and function as well as tendon mechanical properties but also affords protection against neuromuscular degeneration associated with an inactive life-style.

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BASIC STEPS AND SPATIAL-TEMPORAL DIMENSIONS IN THE PROCESS OF SKILLS ACQUISITION IN ALPINE SKIING

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INTRODUCTION

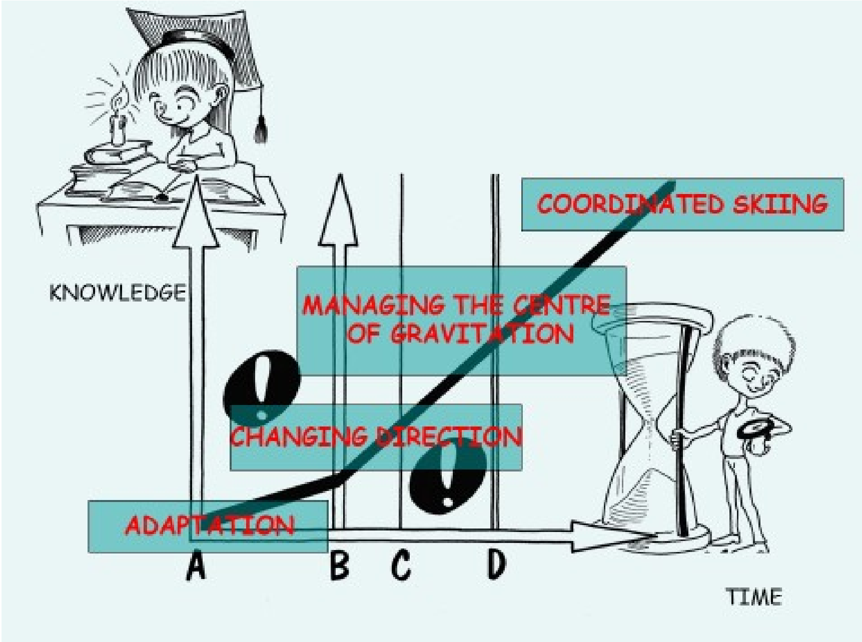
Mastering skiing techniques and good demonstration skills are undoubtedly important ski instructor competences. They are, however, not the only guarantee for the learner to reach the set goal. The instructor should also know the path and the method to get there. This is what distinguishes a good instructor - a creative practitioner - from merely a good skier with no more than knowledge and mastery of figures. So far, this extremely important part of skiing instruction has unfortunately not been given enough attention, particularly such a sensitive field as training beginners from their first steps to when activities on snow already begin intertwining with real ski training. It is in this period that the contribution of a specific expertise is irreplaceable.

There are various ways in which skiing can be presented. It can either be seen as a demanding sports activity or the most beautiful way of experiencing the winter wonderland. However, just like any other sports activity, skiing too begins with learning. To be able to enjoy it also later in life or even upgrade it with real ski training, it must first be learnt. Usually we take it up in childhood, which, of course, is not always a rule. There are certain rules and principles of teaching and learning that apply regardless of the learner's age; while certain age-related characteristics nevertheless require specific approaches.

Ski instruction is a cognitive process in which the learner acquires new skills and thus enriches their motor memory while simultaneously developing the corresponding motor skills. It is a process taking place along certain stages – logically super-structured milestones on the path to skiing ability. The sequence of the acquisition of these stages has a particular importance in learning to ski independently of the tradition or specifics of the ski schools all around the world.

Basic steps in the process of learning skiing

Following the ***familiarisation*** with the new environment, equipment and surface, the child gradually gains the feel for moving in this environment (sliding). On the basis of numerous experiences this is then followed by gaining the feel for ***changing direction*** (a turn) and with that a transition across the fall line. In this phase this transition is carried out by the accentuated loading of one ski throughout the turn. In the next stage, the individual must learn to adjust their own centre of gravity. ***Managing the centre of gravity*** by moving to a higher or lower point, and consequently being able to unload skis at the appropriate time, is a very demanding task for a beginner (for the very young it is almost impossible). It is not until the individual has reached this level of skill that we can set our target on making a fully ***coordinated turn*** with (or without) a pole plant and on dynamic turning along wider or narrower corridors.



Five spatial-temporal dimensions of movement efficiency in the process of skills acquisition in alpine skiing

When advancing through the mentioned key stages in acquiring skiing skills, the skier must gradually also acquire important dimensions of movement efficiency which will take them from the first challenging steps to their maximum enjoyment on the white slopes.

In terms of physics, completion of any physical task is a specific way of overcoming the force of gravity in the dimension of time that the individual's body is capable of while being influenced by the environment and the equipment. This is an extremely complex process involving different areas of individual expression. On the basis of the information received from the environment, awareness of one's own body and previous experience, the individual creates an appropriate motor response and executes it with greater or lesser competence through physical action, dependent on the level of motor skill development and the quantity of acquired motor knowledge. In motor learning as well as in exercise, training or even racing, the success of this process depends on certain important dimensions, which, in the course of a single motor action, occur in a specified sequence and provide the necessary precondition for a consistent and successful completion of the action (Pišot, Kipp, Supej, 2015). These dimensions are:

- Accuracy of motor task completion
- Speed of motor task completion
- Timing of motor task completion
- Rhythm of motor task completion
- Softness of motor task completion

This process always takes place alongside the simultaneous and significant impact of environmental factors - space, surface, equipment, etc. These factors are all the more important when performing motor tasks, the individual is constantly at risk of losing their balance (e.g., slipping) and heavily dependent on the surface (slope of the terrain, type and temperature of snow) and equipment (sidecut of the skis, quality of the ski boots, suitability of the bindings, etc.).

Accuracy of motor task completion

In particular, it is the force of gravity in the dimension of time that causes the most trouble in performing a motor task. In the initial stage, the control of the motor task is still coarse, unrefined and until a sufficient level of precision and timing has been reached, satisfying the conditions for completing a task (e.g., a turn in a precise, wanted place), the realisation of the task (e.g., a turn) is impossible. When a sequence occurs - a sequence of movement patterns (proper placement of skis, shifting the centre-of-mass, movement of the body, etc.), which is still uncoordinated and clumsy, but accurate enough to enable rough completion of a motor task, the first condition on the way to motor efficiency is satisfied.

Speed of motor task completion

Speed is the dimension that has a twofold effect on completing a motor task. For the smooth and rational execution of an initial and sufficiently precise motor task, it is essential to achieve the optimal speed – completion of a task at a speed (rather than fast implementation). Speed facilitates execution of a movement and, through acceleration and limiting the time required for the necessary sequence of movements, leads the individual to a progressive automation of initial movement patterns. Thus, for example, performance of a turn in a wedge or later on already in a parallel position becomes less and less an arduous and difficult task. Nevertheless, performing motor tasks at increasing speed can also cause discomfort and fear. When performing motor tasks in which the body is sliding through space (skating, snowboarding, skiing) the centre-of-mass, affected by the statokinetic reflex, shifts downwards and backwards which results in an incorrect position on the skis - and even faster gliding. Speed, which makes skiing easier but can also limit and inhibit the student, should be gradually increased and consciously and systemically included among the basic factors of learning and training in the snow.

Timing of motor task completion

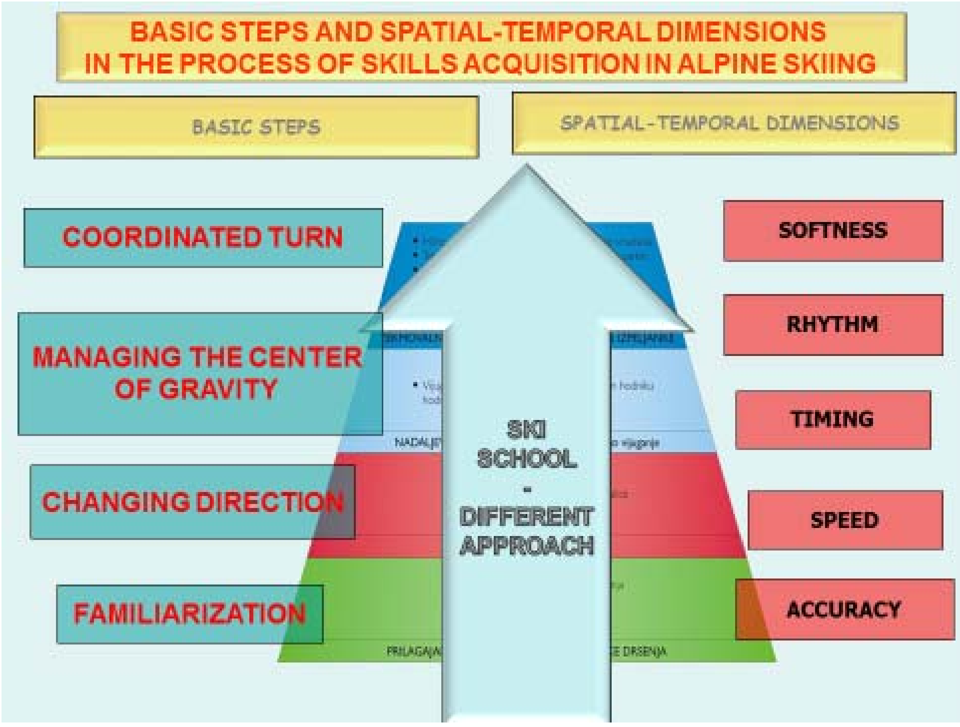
Timing of the execution of movement patterns and the sequence of movements which the skier can already execute with sufficient precision and at optimal speed when performing a certain motor task, leads to an increasingly coordinated and efficient movement. In terms of the energy needed to complete the task, this coordination can be considered as successful and rational, but above all it is reflected in the beauty of movement and in the satisfaction of the individual, who at this stage is already quite pleased with their physical self-image. In skiing, this can be seen in good management of one's centre-of-mass while gliding on skis and in timely push-off, unloading and directing the skis into turns. The addition of pole-planting in the sequence of movements comprising the ski turn marks a significant milestone in the cyclical nature of the movement and at this point we already have before us a good skier.

Rhythm of motor task completion

When the individual has mastered a certain motor task to the extent where it can be performed accurately, quickly and with coordination, they are then ready to move to a more advanced movement, the implementation of which is open to possibilities of creativity and leading edge. A rhythmic performance of a motor task along with the ability to modify and adapt the chosen or dictated rhythm requires not only the optimal speed (performance at a speed) and coordination of performance but also a fast and rhythmically coordinated implementation. Skiing thus provides the individual with a range of enjoyments while they are racing in coordinated turns towards the foot of the hill in a rhythm that can be chosen, modified or determined by the width (layout) of the ski run. This dimension is indispensable if we wish to emphasise the importance of the result.

Softness of motor task completion

Softness in performing a motor task is the highest level of movement efficiency an individual can develop. One must possess a high amount of motor knowledge and well developed motor skills in order to achieve this dimension that enables a precise, coordinated and rhythmic execution of the motor task. The motor task can now be performed both quickly and at speed. Relaxation and softness in the implementation of the motor task are crucial in achieving top performance that will be successful regardless of the rapid changes in the environment and even the most stereotypical situations and requirements. In the diapason of skiing enjoyments, this dimension is certainly at the very top. It is reflected through an entire range of ski services and enables the individual to achieve pleasure and beauty of movement. Without softness it is impossible to achieve a quality level of skiing in fresh, deep snow or in difficult racing conditions in demanding technical disciplines such as slalom or downhill run, performed at extreme speeds. When the skier is in such a complex situation, entailing extraordinary effort and the last atoms of power, but remains responsive enough to accept and correct minor discrepancies and errors as directed by the current situation, then we can affirm that all the necessary dimensions of quality skiing have merged together, including accuracy, speed and timing, rhythm and softness of performance.



As shown in the diagram, the presented dimensions of movement efficiency follow the key stages in acquiring skiing skills through ski instruction, practice and training. Regardless of individual ski school services, which usually differ between individual alpine schools (Slovenian, American, French, Italian, Austrian, etc.), in learning and practising skiing we cannot afford to bypass the stated basic steps and dimensions of movement efficiency. Each individual skier must attain and surpass them on their own. The ski instructor must be familiar with these stages and dimensions and must also be aware of their significance and role in order to enable the students to achieve them in the friendliest manner possible. In this context, the services agreed upon in individual alpine schools are only a means and a path.

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FORCE-VELOCITY RELATIONSHIP: HOW TO TRAIN TO GET STRONGER, FASTER OR BOTH

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UDC 796.012.1

SUMMARY

The manipulation of external loads provides a range of force and velocity data that allows for the assessment of approximately linear force-velocity (*F-V*) and parabolic power-velocity (*P-V*) relationship of the tested muscles. The regression parameters of these two relationships could be of a high reliability and at least moderate concurrent validity. We recently conducted the study aimed to explore the effects of training against different types of loads on muscle force (*F*), velocity (*V*), and power (*P*) output. The results revealed that although all 3 loads resulted in increased *P*, the inertia type of the training load could be somewhat more effective than weight. Even more important finding could be that the *P* increase could be almost exclusively based on either a gain in *F* (when weight is applied), or gain in *V* (when inertia is applied), or both (when weight-plus-inertia is applied).

Keywords: force-velocity; power-velocity; load; training; parameters

INTRODUCTION

Success in many sport activities such as throwing, jumping, cycling, sprinting etc., depends on ability of an athlete to perform rapid movements. High movement velocity (*V*) inevitably requires the exertion of high muscle forces (*F*) so the weight and inertia of body segments or added objects could be overcome within limited time. Since the product of *F* and *V* represents power (*P*), the production of high muscle power output ($P = F \cdot V$) has also been considered as an important prerequisite for rapid movement performance. Therefore, the force-velocity (*F-V*) and power-velocity (*P-V*) relationships have been consistently investigated in various researches on muscle mechanics. Moreover, both the training and testing methods related to muscle *F*, *V*, and *P* outputs have been in focus of research for decades.

Force-velocity properties of single-joint movements

Seminal studies conducted on both isolated animal muscles (Hill 1938; Fenn and Marsh 1935) and human single-joint movements (Wilkie 1950) revealed a well-known hyperbolic *F-V* relationship (see Fig. 1 – left panel). Since power (*P*) represents a product of *F* and *V*, *F-V* relationship directly determines the pattern of *P-V* relationship. Note that due to a non-linear *F-V* relationship, the *P-V* relationship is also of a complex shape and partly skewed towards lower velocities (see dashed line in Fig. 1 – left panel). The relative complexity of both relationships limits not only the accuracy of their assessment from various functional movements, but also their application in various modeling and optimization procedures, as well as in designing athletic training and rehabilitation interventions.

Force-velocity properties of multi-joint movements

While the *F-V* relationship of individual muscles and muscle groups tends to be non-linear, some early studies performed on maximum performance multi-joint tasks have suggested that approximately linear relationship could exist between the *F* output and *V* of either the entire body or body limbs (Vandewalle et al. 1987). More recently, approximately linear *F-V* patterns have been obtained from various vertical jumps (Cuk et al. 2014; Sheppard et al. 2008), simultaneous leg extensions where leg muscles act through closed kinetic chains (Samozino et al. 2012, 2014), cycling (Vandewalle et al. 1987), and various arm and upper body movements (Hintzy et al. 2003; Sprague et al. 2007; Sreckovic et al. 2015). Typically, a manipulation of external load provides a range of F and V data that allows for applying a linear regression model

$$F(V) = F_0 - aV \;, \qquad \text{(eq.1)}$$

where F_0 is F-intercept corresponding to the maximum isometric F (i.e., F at zero V), while a is the slope that corresponds to F_0/V_0 where V_0 is the V-intercept (V at zero F; see Fig. 1 – right panel). Since the P output represents a product of F and V, the linear F-V relationship (eq.1) gives a relatively simple parabolic P-V relationship

$$P(V) = F(V)\,V = F_0\,V - a\,V^2 \;, \qquad \text{(eq. 2)}$$

with the maximum value

$$P_{max} = (F_0\,V_0)/4 \;, \qquad \text{(eq. 3)}$$

exerted at the velocity $V_0/2$ and force $F_0/2$ (Cuk et al. 2014; Jaric and Markovic 2013; Sprague et al. 2007; Suzovic et al. 2013). Therefore, the shape of both the F-V and P-V relationship of the tested muscles is determined by numerical values of 3 mutually dependent parameters (i.e., F_0, V_0, and P_{max}) that have apparent physiological meaning (see Figure 1 – right panel). Specifically, F_0 represents muscle strength, V_0 the ability of achieving high movement velocity, while P_{max} represent the maximum power output.

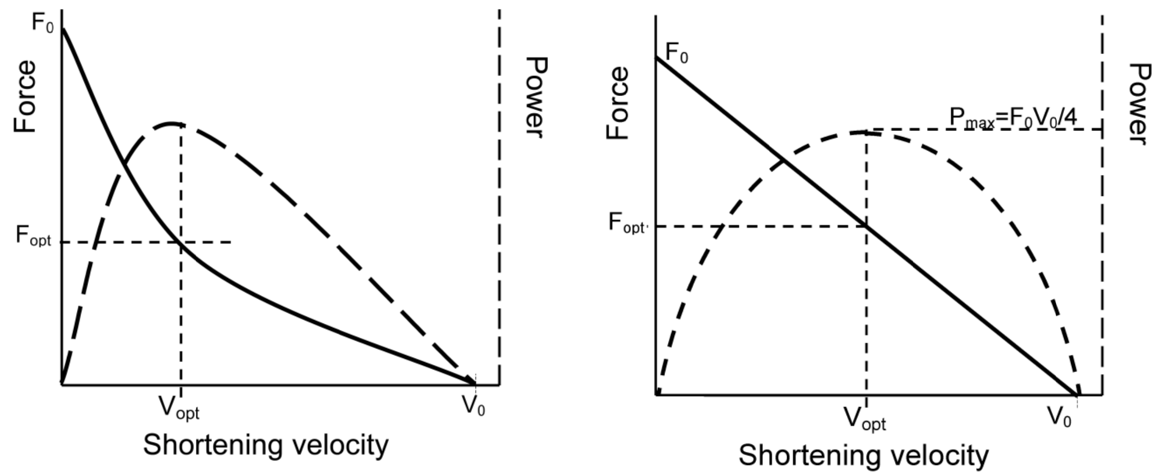

Figure 1. *Left hand panel shows classical F-V (solid line) and the corresponding P-V (dashed line) relationship typically obtained from isolated muscles and voluntary contractions of single-joint muscles. Right hand panel show the same relationships obtained from loaded functional multi-joint tasks.* F_{opt} *denotes to the muscle F that overcomes the optimum external load that results in the optimum shortening* V_{opt} *for maximizing P.*

Reliability, validity, and sensitivity of force-velocity parameters

To justify the use the linear model of the F-V relationship obtained from loaded functional movements for the purpose of the assessment of muscle properties, of essential importance are the properties of their parameters. Our two recent studies evaluated the reliability of F-V relationship parameters (Sreckovic et al. 2015; Cuk et al. 2014). Most of the parameters revealed high reliability across various types of vertical jumps and bench press throws (i.e., all $ICC > 0.80$), while F_0 and P_{max} could be somewhat more reliable than V_0.

Regarding the concurrent validity of its parameters, the findings have been partly inconclusive. For example, the concurrent validity of F_0 with respect to directly measured muscle strength could be from moderate-to-high (Cuk et al. 2014; Vandewalle et al. 1987; Sreckovic et al. 2015) to low and partly insignificant (Ravier et al. 2004; Yamauchi and Ishii 2007). The concurrent validity of V_0 could be either low (Cuk et al. 2014) or moderate (Yamauchi and Ishii 2007). Conversely, the concurrent validity of P_{max} could be particularly high when obtained from the range of external loads close to the optimum load (Cuk et al. 2014; Sreckovic et al. 2015). Finally, some studies found that the concurrent validity could be higher in P_{max} and V_0, than in F_0 (Ravier et al. 2004; Yamauchi and Ishii 2007).

Regarding the sensitivity of the *F-V* parameters (i.e., F_0, V_0, and P_{max}), the literature review indicates findings obtained from cross-sectional design. There are no studies that have assessed and compared the sensitivity of *F-V* relationship parameters for detecting outcomes of various athletic training or rehabilitation interventions. We recently conducted the study that investigated *F-V* relationships observed from strength trained, physically active, and sedentary individuals (Cuk et al, submitted). Apparently, the strength trained and sedentary individuals reveal the highest and lowest *P*, respectively, while the differences among the tested groups could originate more from the differences in F_0 than in V_0. These results suggest that the applied linear *F-V* model could be sensitive enough to discern among the muscular properties of individuals of different physical abilities.

The effect of different types of training loads on force-velocity relationship

The most frequently used external resistance in athletic training typically originates from a lifted mass (m) typically including body segments and added weights. Such exercises require a muscle force:

$$F(t) = m\,g + m\,a(t) = W + I, \qquad \text{(eq.4)}$$

where g is the gravity acceleration, and W and I are the F components acting against the weight and inertia, respectively. Note that while W represents a constant force, I changes over time depending upon the acceleration of the center of mass a. This type of load consisting of W and I ($W+I$) generally proved to be effective in increasing muscle *F*, *V*, and *P* (Cormie et al. 2011; Drinkwater et al. 2005). Conversely, the load that predominantly provides only a constant force and therefore mimics only W has been used either in single-joint movements controlled by isokinetic devices, or against long and heavily extended rubber bands (Markovic and Jaric 2007; Markovic et al. 2013; Markovic et al. 2011). Finally, the I resistance imposed without W has been rarely applied in training since it acts only in ether rapid swings and push-offs performed predominantly in horizontal plane [e.g., horizontal throws, push-offs, or kicks (Liu et al. 2011)] or when training against a flywheel (Naczk et al. 2013). Note that the importance of the discussed distinctive types of load has been implicitly recognized even in development of space technology since the Advanced Resistive Exercise Device manufactured by the National Aeronautics and Space Administration was specifically designed to provide both W and I type of external load (Loehr et al. 2011). Nevertheless, the specific effects of training against W and I type of loads have never been explored although they represent the basic mechanical properties of both the body segments and external objects moved with them.

We recently design the study to investigate the underexplored selective effects of training against different types of loads on mechanical properties of arm muscles (Djuric et al., submitted). Specifically, the participants practiced bench press throws (BPT) against the loads that predominantly corresponded to W, $W+I$, and I. We assessed the *F-V* relationship of the trained muscles to discern among the effects of the applied training on their *F*, *V*, and *P* output.

METHODS

Subjects

The subjects (N=48) were male physical education students of 20.5 ± 2.0 years (mean ± SD) of age. The subjects were randomly assigned to one of the following four groups: Weight group (WGr; N = 12; 1 repetition maximum bench press [1RM] = 79.6 ± 11.4 kg), Weight-plus-inertia group (W+IGr; N = 12; 1RM = 82.9 ± 10.5 kg), Inertia group (IGr; N = 12; 1RM = 82.9 ± 11.0 kg), and Control group (CGr; N = 12; 1RM = 82.1 ± 10.3kg).

Testing procedure

The design of the study was longitudinal with training intervention and random assignment. The protocol consisted of the pretest, 8-weeks of training intervention conducted on the 3 experimental (WGr, W+IGr, and IGr), but not on the control group (CGr), and the posttest. Specifically, the 2 testing sessions were conducted prior to (i.e., pretest) and another 2 sessions 4–7 days after the training (posttest). The first and second posttest session included the testing of 1RM and BPT, respectively. 1RM was tested on a Smith Machine according to the standard procedure. Loaded BPTs aimed to provide a range of the force (*F*) and velocity (*V*) data for further analysis were also performed on a Smith machine. The participants were instructed 'to throw the bar as high as possible' from a static starting position. The external loads (i.e., the total weight of two arms, bar, and weight plates) applied through a weighted bar of a Smith machine corresponded to 30, 37, 44, 51, 58, 65, 72 and 79 % of the subject's 1RM. Their sequence was randomized. Only the pre- and posttest BPT performed against 8 external loads were analyzed. The *F-V* relationships were assessed from the individual *F* and *V* data obtained under 8 load magnitudes and the corresponding parameters (F_0, V_0 and P_0) were calculated.

Training procedure

A previously used combination of the attached rubber bands with the weight plates added to the bar on the modified Smith machine (Leontijevic et al. 2013) was used for the purpose of the applied training intervention (see Fig. 2 for illustration). Specifically, the long and heavily extended rubber bands pulling downward with an approximately constant force mimicked *W* in WGr (Fig. 2A). Addition of the plates to the bar inevitably resulted in an increase in both the *W* and *I* (W+IGr ; Fig. 2B). Finally, co-varying of the weight plates with the rubber bands pulling upwards mimicked *I* only (IGr; Fig. 2C). All 3 training loads corresponded to the load of 40 kg that approximately represented 50% of 1RM in all subject groups. The supervised BPT training was conducted over an eight-week period, three times per week. The number of sets and repetitions of BPT through training sessions was as follows: 6 sets of 7 repetitions during the weeks 1 and 2, 7 sets of 7 repetitions during the weeks 3 and 4, 8 sets of 7 repetitions during the weeks 5 and 6, and 9 sets of 7 repetitions during the weeks 7 and 8. CGr subjects were only advised to maintain their current daily activities throughout the duration of the study.

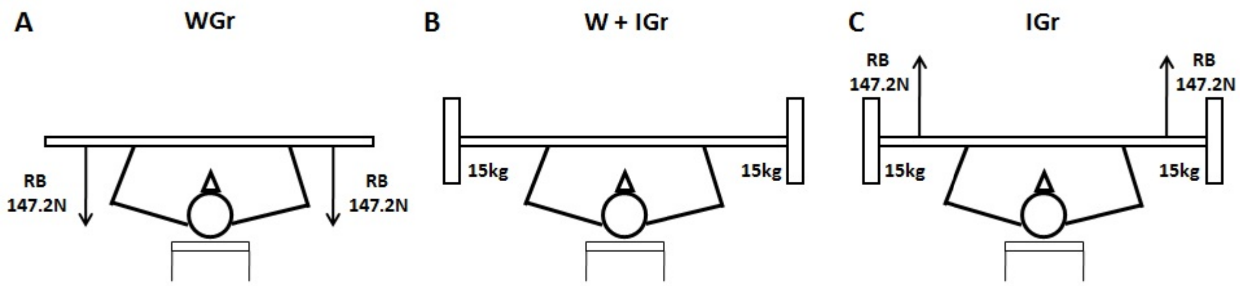

Figure 2. *Illustration of 3 types of the training loads. The mass of hands and bar provides the 'reference load' of approximately 10 kg common for all 3 types. The equivalent of the remaining 30 kg was imposed either by approximately constant force of stretched rubber bands (RB) that mimicked weight (W; panel A), or by adding 30 kg of weight plates that increased both the weight and inertia (W+I; panel B), or by inertia (I; panel C) of the same plates, whereas their weight was compensated by the force of RB pulling upwards.*

RESULTS

Figure 3 shows the *F-V* relationships of 3 representative subjects obtained from eight loading magnitudes applied during the pretest and post-test. The data suggest a training associated increase in P_0 (i.e., the product of F_0 and V_0) observed in all 3 subjects. Of particular importance could be that the same increase could be predominantly based either on a gain in F_0 (WGr subject; Fig. 3A), or gain in V_0 (IGr subject; Fig. 3C), or both (W+IGr subject; Fig. 3B).

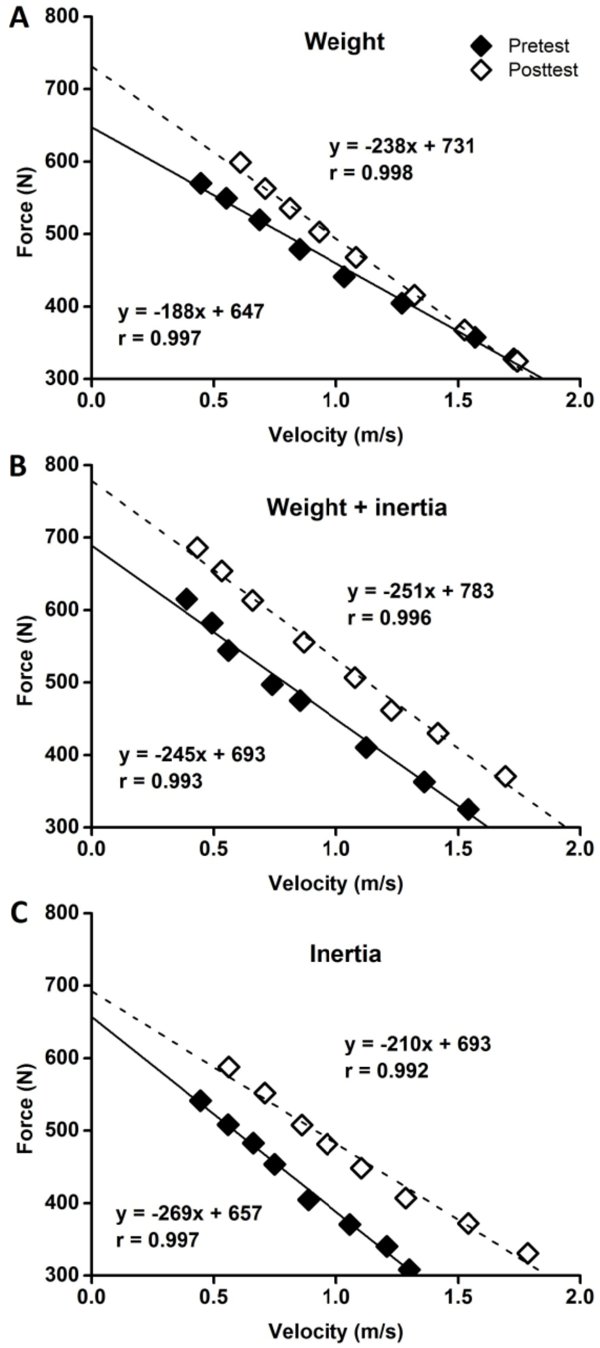

***Figure 3**. Linear regressions obtained from the pre-test (solid lines; filled squares) and posttest (dashed lines; open squares) of representative subjects of the weight (WGr; panel A), weight + inertia (W+IGr; panel B), and inertia group (IGr; panel C). The individual points represent the F and V data observed from 7 different loads.*

The main finding of our study represents the effects of training against different types of load on the *F-V* relationship parameters (see Fig. 4). The left hand panels depict averaged across subjects parameters calculated from the individual *F-V* relationships observed from the pretest and post-test. Right hand panels of Figure 4 depict the gains in the *F-V* relationship parameters observed between the pretest and post-test only in 3 experimental groups, since the same gains obtained from CGr where not meaningful. Collectively, the results are in line with the data obtained from representative subjects (see Fig. 3) suggesting that while the P_0 gain in W+IGr was based on an increase in both F_0 and V_0, the same gain in IGr and WGr was based almost exclusively on an increase in V_0 and F_0, respectively.

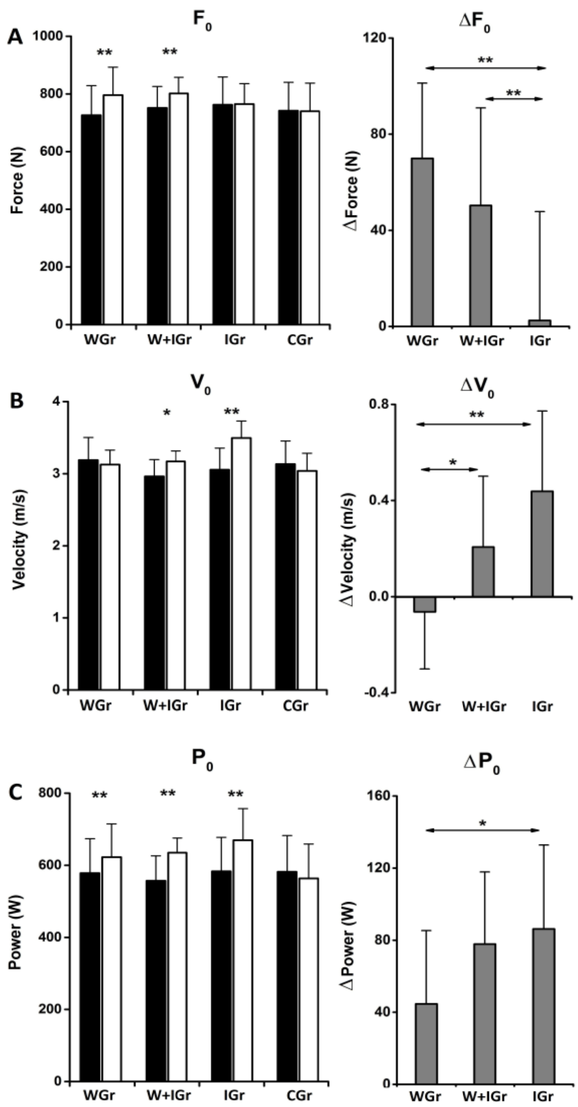

Figure 4. *Left hand panels depict the averaged across the subjects values of the F-V relationship parameters (A - force intercept F_0; B - velocity intercept V_0; C - maximum power P_0) with SD error bars obtained from the pre-test (filled bars) and posttest (empty bars) in the 3 experimental and the control group. The differences between the tests are also indicated (* $p < .05$; ** $p < .01$; paired t-test). Right hand panels present the absolute differences in the same parameters observed between the pre-test and posttest in 3 experimental groups (* $p < .05$; ** $p < .01$; 1-way ANOVA).*

CONCLUSIONS

Our study revealed an advantage of using *I* over *W* type of training load to increase *P*. Even more novel finding could be that the *W* training load could increase *P* through the gain in *F*, *I* load increases *P* through a gain in *V*, while the most frequently applied *W+I* training load increases *P* through a gain in both *F* and *V*. From the methodological perspective, the most important finding could be that the linear model of *F-V* relationship obtained from loaded trials could be sensitive enough to discern among the training associated gains in *F*, *V*, and *P*. Therefore, we conclude that (1) *I* training load could be more effective than *W* in increasing *P*, (2) *W* and *I* training loads could be applied for selective gains in *F* and *V*, respectively, while (3) the linear *F-V* model obtained from loaded trials could be recommended for discerning among the maximum *F*, *V*, and *P* output of tested muscles.

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Sport

STUDY OFF PHYSIOMETRIC INDICATORS OF BICYCLISTS IN AGE 16 YEARS

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UDC 796.61:612

SUMMARY

Tests and measurements at the stage of initial sports training are an excellent tool for discovering the makings for one or the other cycling discipline. This is what prompted us to conduct this study. For the determination of the level of development of individual qualities, as well as for the purposes of the study, were separate tests (the indicator), illustrating the physiometric characteristics of the studied individuals. The purpose of the study is to: determine the dynamic characteristics for improving physical development and physical abilities of the adolescents 16-17 year-olds practicing cycling. The subject of the research are the physical skills of cyclists from Bulgarian which are competitors of the k.k. NSA Sofia and are aged from 16 to 17 years. The results obtained are carriers of the salient features of the investigated persons and on general trends in the development of the appropriate age. This makes them applicable to this age in each country.

Keywords: research, control, potential, qualities, contestants.

INTRODUCTION

For the development of Junior sport paramount acquire the Organization and management of sports training. The actuality of the problem becomes greater, depending on the growth and development of adolescents. Simultaneously with the anthropometric and physiometric amendments earlier mature structurally functional systems that determine the physical abilities.

The provision of a comprehensive physical training of young cyclists age requires knowledge about their physical development and consideration of age patterns for the development of physical qualities. The study in the age aspect is important when working with cyclists and management of sports training.

Tests and measurements at the stage of initial sports training are an excellent tool for discovering the makings for one or the other cycling discipline. This is what prompted us to conduct this study.

METHODS

The purpose of the study is to: determine the dynamic characteristics for improving physical development and physical abilities of the adolescents 16-17 year-olds practicing cycling.

The subject of the research are the physical skills of cyclists from Bulgarian which are competitors of the k.k. NSA Sofia and are aged from 16 to 17 years.

The survey completed in June 2015 with a summary and analysis of the information collected.

For the determination of the level of development of individual qualities, as well as for the purposes of the study, were separate tests (the indicator), illustrating the physiometric characteristics of the studied individuals. The tests provide an opportunity for a broad view on overall development. They are affordable and easy to measure and control, suggesting as obtaining objective information for the researcher and the coach, and also an opportunity for the implementation in practice of all those found with high functionality and relevance for the cycling sport.

RESULTS

Table 2 presents the results obtained from the primary and final examination of 4 dynamic (physiometric) indicators.

The results obtained from the tracked physiometric indicators we can explain with the greater volume of training work in the past two months.

Table No. 1 Physiometric indicators

№	Physiometric indicators	n = 20				
		x_1	x_2	*d*	*t*	*Pt*
1.	Force of right hand	65,0	72,0	7,0	16,97	0,99,9
2.	Force of left hand	58,0	62,0	4,0	6,03	0,99,9
3.	Stanova force	106,0	137,0	31,0	6,08	0,99,9
4.	Vital capacity	4970,0	5670,0	700,0	10,78	0,99,9

The data obtained from the tracked metrics for physical development and physical abilities we more variacionniâ analysis: the statistical indicators for the average level of the signs at the beginning of our research - X_1 and at the end of the - X_2 the difference between them - d, t- the criterion and the respective trust probability Pt. The difference between the X_1 и X_2 is substantial, i.e. There is a probability of a trust enhancement Pt = 0,99. When you trust a probability of less than 0.90 assuming that the difference is negligible, or the result is with lower values.

Strength of the arm (right and left) reflects the ability of the rider to effortlessly place contact with bicycles. On the other hand – it is the expression of the natural development and growth of the organism in the research period. Have measured our it with 90 kg manual dynamometer with an accuracy of up to 2 kg. Youth Studies placed the dynamometer in the hand and upper limb without folds or rests, the got sharply and with maximum force dynamometer. The study individually which of both hands (2-3 times) and taking into account the highest values.

Stanova force (the force of the body) is a measurement of the strength of the dorsal caudate-pelvic musculature and in particular the power of razg″vači muscles of the back.The measurement made with the dynamometer in accordance with article with an accuracy of 5 kg. Cyclist under investigation was set in the feet apart stance (feet apart at shoulder width). The dynamometer shall be secured by a chain, so that the handle is height of the knees, and the chain to point the center of gravity of the body. The contestant pulls strongly dynamometer using the power of the dorsal caudate-pelvic musculature without flexes elbow and knee joints. Which measure 2-3 times higher value can't get in trouble. Before the contestants performed several measurement exercise of the dorsal caudate-pelvic musculature. Vital capacity (vital capacity) of the lungs, gives an idea of their functional ability and power of respiratory muscles. Have measured our it with water an incentive spirometer with accuracy up to 50 cm3. Studies breathed deeply several times and after short break assumes the maximum amount of air that breathes in the spiromet″ra for 5-6 seconds. Which measure 2-3 times by taking the highest value.

DISCUSSION/CONCLUSION

1. The system cycling activities stimulate the development of the physical qualities in the most favourable age period for this purpose. It is more targeted and in-depth to be developed and used in the sports practice, tools and methods to speed up this development
2. The results obtained are carriers of the salient features of the investigated persons and on general trends in the development of the appropriate age. This makes them applicable to this age in each country.
3. Regular cycling activities stimulate the physical development of young cyclists, but must take into account the age and hereditary patterns for the creation of a solid and lasting foundation for the further refinement of the physical qualities.

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Kolev, I., Iliev. D. Study of the motor potential of 13 to 14-year-old racing cyclist. Међународни научни скуп “Fis Communications 2014” Nish.

TRACKING IN THE AGE ASPECT OF DEVELOPING PHYSICAL QUALITIES OF 16 YEAR-OLD BIKERS

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UDC 796.61:012

SUMMARY

Tracing in the age aspect of the development of the physical attributes of speed, muscle strength, endurance, flexibility, and others have important implications for young cyclists in terms of system training-training process. The subject of the research are the motor (physical) abilities of 20 boys – cyclists from Bulgarian which are competitors of the k.k. NSA Sofia and are aged from 16 to 17 years. The results obtained are carriers of the salient features of the investigated persons and on general trends in the development of the appropriate age. This makes them applicable to this age in each country.

Keywords: research, control, potential, performance

INTRODUCTION

The development of modern cycling and his increasingly narrow specialization requires necessarily deepen knowledge of the building of the human body. This requires a more detailed disclosure of relationships between body structure and the functional capabilities of people, improving methods of their study, creating a model for morphological characteristics separate varieties and disciplines of koloezdačniât sport.

Physical abilities is used in the theory and methodology of physical education and sports training, and also in their disciplines. As the concept is used in almost all other areas where occurs the motor activity of the man [5].

Tests and measurements at the stage of initial sports training are an excellent tool for discovering the makings for one or the other sports discipline. This is what prompted us to conduct this study.

METHODS

The aim of the study was: study and track the physical qualities of development in adolescents 16-17 year-olds practicing cycling.

The subject of the research are the motor (physical) abilities of 20 boys – cyclists from Bulgarian which are competitors of the k.k. NSA Sofia and are aged from 16 to 17 years.

Tracing in the age aspect of the development of the physical attributes of speed, muscle strength, endurance, flexibility, and others have important implications for young cyclists in terms of system training-training process. They are affordable and easy to measure and control, suggesting as obtaining objective information for the researcher and the coach, and also an opportunity for the implementation in practice of all those found with high functionality and relevance for the cycling sport.

RESULTS

The plan of our study was to select the most informative tests for the measurement of the structural components of the capacity. The choice made by the "list of tests for the study of the physical abilities" proposed by L. Petkova and M. Kvartirnikova (1985), which contains 56 tests. Given the limited time available for research, we have selected only 8 tests that measure to a greater extent a motility and are available for implementation depending on the conditions under which I had to explore.

Testing was carried out on the standard methods of measurement for each of the tests pertaining to the physical development of the investigated persons sport-technical capabilities, as well as the rapidity of the lower limbs were measured on the established methodologies for measuring it in cycling and athletics.

Tracing in the age aspect of the development of the physical attributes of speed, muscle strength, endurance, flexibility, and others have important implications for young cyclists in terms of system training-training process. Table 1 presents the results obtained from the physical test tracked 8 capacity.

Table No. 1

№	Physical capacity	п = 2 0				
		x_1	x_2	d	t	Pt
1.	60 m Sprint (low start)	9,17	8,71	0,56	2,23	0,95
2.	Jump from both feet	234,87	245,0	10,13	2,25	0,99
3.	Vertical bounce from a place with both feet	43,0	52,9	9,90	3,03	0,99
4.	Props to refusal	40,40	50,40	10,0	22,9	0,99,9
5.	Maximum number of sit-ups (20 sec)	18,0	21,0	3,0	8,0	0,99,9
6.	The depth of the slope (flexibility)	8,95	17,65	8,70	3,07	0,99
7.	Run 3000 m.	13:16	12:55	0:21	3,04	0,99
8.	The crowbar Tegene 50 kg from leg-100 PCs. For time	6:10	5:50	1:0	4,1	0,99,9

From the table we can see that the initial results from the 60 m Sprint (low start) have been improved with 0,56 at t = 2.23 and trust probability of Pt = 0.95

In the long jump in with both feet improvement is with 10.13 cm t = 2,25 and trust likely Pt = 0.99.

Improvement of the vertical rebound from a place with both feet with 9.9 cm, t = 3.03 and trust probability of Pt = 0.99.

The first implementation of the supports to the denial is X = a in the second 40,40 x 2 = 50,40 or improvement is on average 10 times when trust probability of Pt = 0.999.

The maximum number of sit-ups in 20 seconds at the first examination is Xx = 18.0, and when the second X 2 = 21.0, the difference is with 3 sit-ups-t = 8.0 and trust probability of Pt = 0.999.

The depth of the slope (flexibility) is increased by 8.70 — t = 3: 07 in trust probability of Pt = 0.99.

From the table we can see that there is an improvement in the results of the running of the 3000 m with 0: 21 min-t = 3.04 and trust probability of Pt = 0.99.

Significant improvement in the draw of 50 kg barbell from leg-100 times for time-y min. (t = 4.1 and Pt = 0.999).

Summing up the results of the survey for speed, otskoklivostta, dynamic strength, flexibility and endurance obtained after systematic activities, we can make a conclusion that it is necessary to carry out regular studies on the physical capacity to serve as a comparison for the coaches in cycling.

DISCUSSION/CONCLUSION

1. The system cycling activities stimulate the development of the physical qualities in the most favourable age period for this purpose. It is more targeted and in-depth to be developed and used in the sports practice, tools and methods to accelerate this development.
2. The results obtained are carriers of the salient features of the investigated persons and on general trends in the development of the appropriate age. This makes them applicable to this age in each country.

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Kolev, I., Iliev. D. Study of the motor potential of 13 to 14-year-old racing cyclist. Међународни научни скуп “Fis Communications 2014” Nish.

RELATIONS BETWEEN NEUROMUSCULAR CONTRACTILE PROPERTIESOFLEG MUSCLES MEASURED WITH ISOKINETIC AND TMG METHODS: PILOT STUDY

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UDC 796:615

SUMMARY

Musclecontractileproperties are of interest to expertsboth in the field of sport and in other scientific fields. There are numerous methods for assessing neuromuscular contractile properties. One of the methods for the assessment of voluntary and involuntary neuromuscular contractile properties is a method of isokinetic dynamometry and tensiomiography (TMG). So far there have been no studies that dealt with relations between the two methods, or relations between the test results ofisokinetic dynamometry and tensiomiography. The aim of this research is to study the relationship between tests for the assessment of voluntary neuromuscular contractile properties measured by the method of isokinetic dynamometry and involuntary neuromuscular contractile characteristics measured by the method of tensiomyography in knee joint extensor and flexors muscles.In the sample of 24 healthy, active men (24.03±4.5 years) there were measured neuromuscular contractile properties of leg muscles using the isokinetic dynamometer andTMG. Calculation of the Pearson correlation coefficient led to the results which indicate that there is a statistically significant correlations between the variables of the average flexor muscle powerof the right leg knee joint at a speed of 60˚/s (H_PavgD60) andRMTDof vastus lateralis($r=0.42$; $p<0.05$) and semitendinosus muscle ($r=0.41$; $p<0.05$). When the left leg is in question, there is a correlation between the average power of knee jointextensor muscleat a speed of 60 ˚/s (Q_PavgL60) and RMTD of rectus femorismuscle ($r=0.42$; $p<0.05$) andTcof vastus medialismuscle ($r=0.41$; $p<0.05$). In the left leg there is also a correlation between the variables of average power of the knee jointflexor muscles at a speed of 60 ˚/s (H_PavgL60) andDm ($r=0.47$; $p<0.05$) or RMTD ($r=0.48$; $p<0.05$) of the muscles vastus medialis. We can conclude that the parameter of RMTDhas the highest correlation with voluntary muscle contractile properties, as well as that the connection between voluntary and involuntary neuromuscular contractile properties of the leg muscles is the largest at a speed of 60 ˚/s.

Key words: relations, contractile properties, tensiomiography, isokinetic dynamometry

INTRODUCTION

The muscles are the most common tissue in the human body, they play a key role in the movements, and therefore muscle contractile properties are the subject of interest to expertsin the field of sports, as well as in other scientific fields. Postural muscle groups that play an important role in everyday activities, such as the leg muscles and back muscles,represent the particular subject of interest. There are numerous methods for assessing neuromuscular contractile properties. One of the methods for the assessment of voluntary and involuntary neuromuscular contractile properties is a method of isokinetic dynamometry and tensiomyography (TMG).

Dinamometry is one of the best methods for the assessment of voluntary neuromuscular contractile properties, or for the assessment of muscular strength and power (Abernethy, Wilson, & Logan, 1995).The isokinetic dynamometer is the instrument which proved to be valid and reliable for assessing muscle power, but also other parameters such as stength, work, and other (van Meeteren, Roebroeck, & Stam, 2002; Drouin, Valovich-mcLeod, Shultz, Gansneder, & Perrin, 2004; Maffiuletti, Bizzini, Desbrosses, Babault, & Munzinger, 2007). Isokinetic dynamometry is based on measurement of muscle power at constant angular velocities, and this is the method which is used for assessment of voluntary neuromuscular contractile properties of athletes, but is frequently used in rehabilitation (Baltzopoulos, &

Brodie, 1989; Abernethy et al. 1995; Caruso, Brown, & Tufano, 2012).

Tensiomyography (TMG) is a relatively new non-invasive method, which in the last 15 years has been used to assess involuntary neuromuscular contractile properties. It was first introduced in 1990 as a method for measuring muscle tone (Valenčič, & Knez, 1997).Tensiomyography can be classified as mechanomyography(MMG), however, some authors argue that there are many differences and advantages of TMG over MMG, primarily those concerning the precision of measurement and signal processing, but also the fact that TMG estimates involuntary muscle contractile properties (Dahmane, Djorđevič, & Šmerdu, 2006; Križaj, Šimunič, & Žagar, 2008; Hunter et al. 2012).Tensiomyography is applied by means of portable appliances, and is based on an estimate of muscle contractile properties under isometric conditions on the basis of changes in the position of muscle belly caused by electrical impulse (Valenčič, & Knez, 1997). Until now, many studies have confirmed the validity and reliability oftensiomyography as a method for assessing involuntary neuromuscular contractile properties (Tous-Fajardo et al. 2010;Šimunič, 2012; Ditroilo, Smith, Fairweather, & Hunter, 2013).Use Tensiomyography can measure the following variables: maximal displacement (Dm), contraction time (Tc), delay time (Td), sustain time (Ts) and relaxation time (Tr). Tensiomyography can be applied in the assessment of muscle fatigue (Garcia-Manso et al. 2011; 2012), assess the types of muscle fibers (Dahmane, Djordjevič, Šimunič, Valenčič, 2005; Šimunič et al. 2011), assess of muscle damage caused under the influence of physical activity (Hunter et al. 2012), injury prevention (Dias, Fort, Marinho, Santos, & Marques, 2010; Alentorn-Geli et al. 2014), assessment of muscular atrophy (Pišot et al. 2008), in cases of pathological conditions (Grabljevec, Burger, Kersevan, Valenčič, & Marinček, 2005; Rusu, Calina, Avramescu, Paun, & Vasilescu, 2009),as well as in children (Pišot et al. 2004).

The problem of this study isthe relation between voluntary and involuntary neuromuscular contractile properties of the leg muscles, or the relation between test results of isokinetic dynamometry and tensiomyography. There have been no studies so far that dealt with relations between the test results of isokinetic dynamometry and tensiomyography. Accordingly, the goal of this research is to examine the connection between the tests for the assessment of voluntary neuromuscular contractile properties measured by the method of isokinetic dynamometry and involuntary neuromuscular contractile properties measured by the method of tensiomyography in knee joint extensor and flexors muscles.

METHODS

The sample of participants

The sample of participants consisted of 24 healthy, physically active men (Age = 24.03±4.5year; Height = 181.86±7.35 cm; Weight = 81.42±8.21 kg; BMI = 24.61±2.1 kg/m^2).All respondents are familiar with the goal of research and voluntarily agreed to participate in the experiment. All tests were performed in accordance with the regulations of the Ethics Committee of the Faculty of Sport and Physical Education, University of Belgrade.

Testing Procedure

The respondents were examined by randomized cross measurement method, where, using the random sample method, in one group of respondents there were first made measurements on TMG, and after a break of half an hour, measurements on the isokinetic dynamometer, while in the other group there were first made measurement on the isokinetic dynamometer and then on TMG. All measurements were performed under the same conditions. The respondents were tested in the morning, they were well rested, not practicing physical activity prior to testing, and all tests were performed by the same experienced measurers.

Voluntary neuromuscular contractile properties were examined using the isokinetic dynamometer Kin-Com AP125 (KinCom, Kinetic Communicator; Chattecx Corp., Chattanooga, TN, USA).Before measuring the respondents were acquainted with theway of performing the task, and they were required before testing to warm up in order to be able to exert maximum power and to avoid injury. Measurements were done in concentric isokinetic mode at speeds of 60 and 120˚/s.Respondents were sitting in a chair, tied around the shoulders, waist and active legto isolate the desired muscles(Figure 1). From this position they were carrying out maximum extension in the knee joint, from the position of flexed knee in the angle of 90˚, and then flex back to the starting position. Respondents were instructed to repeat it maximallyintensely and fast. Each respondentperformed 5 repetitions in two series, at both speeds, and then theaverage of the two series was taken as a final result. A break between the series lasted for 2 minutes. Testing was performed on both the right and left leg. While performingthe task, participants were given the verbal support.

Figure 1: Measuringon the isokinetic dynamometer

Measuring involuntary neuromuscular contractile properties was performed by TMG appliance(TMG-BMC Ltd, Ljubljana). TMG testing was carried out on five muscles: rectus femoris (RF), vastus lateralis (VL), vastus medialis (VM), biceps femoris (BF) andsemitendinosus (SM). Respondents were lying in a relaxed position on their back or stomach, depending on the measured muscle. The angle between the lower leg and thigh was about 135˚. Before placing the electrodes respondents were asked to perform voluntary contraction to have thedesired muscledeterminedusing the method of palpation.

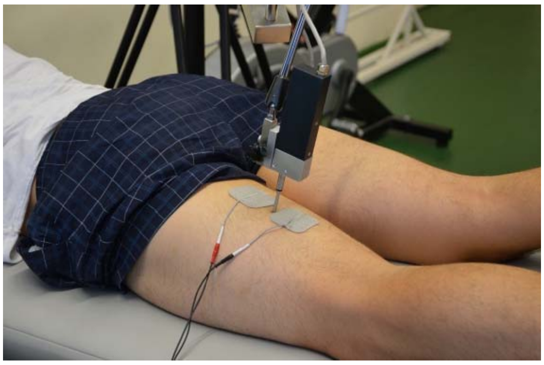


Figure 2: The method of installation of electrodes and sensors

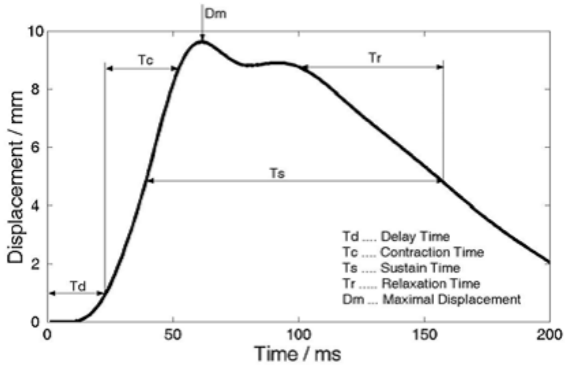


Figure 3: TMGParameters

After determining it, two self-adhesive electrodes which emit the electrical pulse, proximally and distally,are mountedin the central part of the muscle at a distance of about 3 cm from the desired position for the measurement (Figure 2).Among the electrodes there was set up a sensor that detects changes in abdominal muscles caused by electrical stimuli on the basis of which we obtain data on involuntary neuromuscular contractile properties. The electrical pulse used to be obtained by electronic stimulators, it lasted for1 ms, and initial impulse wasintensity of25 mA, with increasing intensity of 20 mA to the maximum, or until the reaction of muscle to increaseof the amplitude was no longer possible. The maximum amplitude ranged from 80 to110 mA.The pause between the pulses was about 5 s, so that muscle could relax.The two best results were saved, and on the basis of them the average one was calculated. On the basis of the maximum muscle response to electrical stimuli we can get the following information (Figure 3):

- Dm (maximal displacement) –maximum vertical muscle displacement during an electrical involuntary muscle stimulation
- Tc(contraction time)– the time needed to reach out 10 to90% of the maximal displacement
- Td (delayedtime)– the time required to reach 10% of the maximaldisplacement

- Ts(sustain time)– the time passed from 50% at the stage of the contraction up to 50% at the relaxation phase
- Tr(relaxation time)– the time taken to lower the contraction from 90 to 50% of the maximal displacement

The sample of variables

The sample of variables consisted of 8 variables from the area of voluntary neuromuscular contractile properties, and 30 variables from the area of involuntary neuromuscular contractile properties. Variables describing voluntary contractile characteristics of the muscle are:

- Average extensor muscles powerin theknee joint of the right leg at a speed of 60 ˚/s – Q_PavgD60 (W),
- Average extensor muscles powerin theknee joint of the right leg at a speed of 120˚/s – Q_PavgD120 (W),
- Average flexor muscles powerof the knee joint of the right leg at a speed of 60 ˚/s – H_PavgD60 (W),
- Average flexor muscles powerof the knee joint of the right leg at a speed of 120 ˚/s – H_PavgD120 (W),
- Average extensor musclespowerof the knee joint of the left leg at a speed of 60 ˚/s – Q_PavgL60 (W),
- Average extensor musclespowerof the knee joint of the left leg at a speed of 120 ˚/s – Q_PavgL120 (W),
- Average flexor muscles powerof the knee joint of the left leg at a speed of 60 ˚/s – H_PavgL60 (W),
- Average flexor muscles powerof the knee joint of the left leg at a speed of 120 ˚/s – H_PavgL120 (W),

The variables that describe the involuntary neuromuscular contractile properties are:

- Tc- contraction time(ms)
- Td - delay time(ms)
- Tr - relaxation time (ms)
- Dm- maximaldisplacement (mm)
- Ts- sustain time(ms)
- RMTD- rate of muscle tension development(mm/ms)

Variable RMTD can not be obtained directly by measuring, but is got by the relationship between Dm and Tc,and is expressed in mm/ms (Dopsaj, Ivanović, &Ćopić, 2014). For each of the five musclesthese 6 variables are calculated for the estimation of involuntary neuromuscular contractile properties.

Statistical data processing

As for the statistical procedures, descriptive statisticswas applied in the work (Mean, Sd, Cv, Min, Max)and the Pearson correlation coefficient was calculated. Descriptive statistics was used to describe the measured variables and the Pearson correlation coefficient was calculated to determine the correlation between the measured variables. All statistical procedure was performed in the program SPSS19.

RESULTS

Table 1 presents the descriptive variablesindicators for assessment of voluntary contractile properties of the muscle. We can seethat exhibited average extensor and flexor muscles powerin the knee joint increased at a rate of 120˚/s, extensors of right and left legs are much stronger than the flexors of the right and left leg, right leg extensors were stronger than the left legextensors, while the left leg flexors are stronger than the right legflexors. Based on indicators of homogeneity of the results(Cv) we can determine that the group which was examined is homogeneous when the average power of flexor and extensor muscles of the knee joint are in question.

Table 1: Descriptive indicators of measured variables of voluntary contractile properties

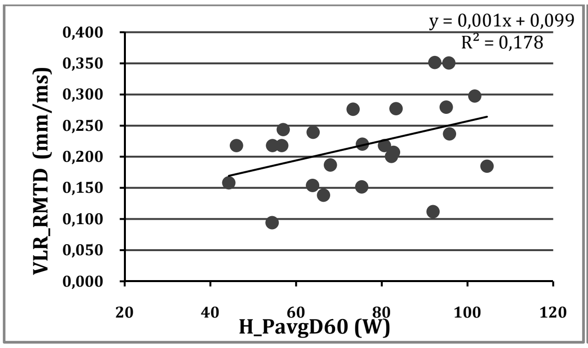
	Mean	Sd	Cv	Min	Max
Q_PavgD60 (W)	120,44	27,27	22,64	84,89	190,54
Q_PavgD120 (W)	194,88	43,61	22,38	125,59	267,9
H_PavgD60 (W)	75,2	17,82	23,7	44,29	104,56
H_PavgD120 (W)	132,52	29,39	22,18	85,15	191,98
Q_PavgL60 (W)	108,52	29,28	26,98	60,67	171,13
Q_PavgL120 (W)	176,24	41,3	23,43	120,65	263,55
H_PavgL60 (W)	81,08	17,71	21,84	52,07	129,3
H_PavgL120 (W)	135,16	26,26	19,43	91,05	197,01

Table 2 presents the descriptive indicators of measured variables of involuntary neuromuscular contractile properties. On the basis of the accompanying results, we can see that the vastuslateralis muscle of the right leg has the shortestTc, the shortestTr, the leastDm and the shortest Ts. Muscle vastus lateralis of the left leg has the shortest Td, while semitendinosus of the right leg which also has the longest Td has the fastestRMTD.Semitendinosus muscle of the left leg has the longest Tc,vastus medialis muscle of the right leghas the longest Tr, biggest Dm and the slowest RMTD, while the biceps femoris of the right leg has the longest Ts. Regarding the indicator of homogeneity of results (Cv), which is not shown in the table, this group of respondents is the most homogeneous when the variable of delay time(Td) is in question, and it is the least homogeneous when the variable of relaxation time (Tr) is in question.

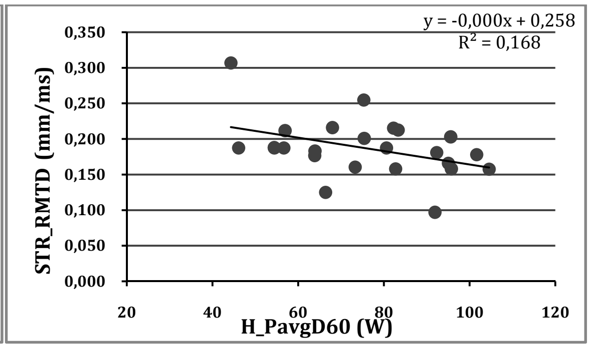
Table 2: Descriptive indicators (Mean±Sd) ofmeasured variables of involuntary neuromuscular contractile properties

		Tc [ms]	Td [ms]	Tr [ms]	Dm [mm]	Ts [ms]	RMTD (mm/ms)
RF	**R**	28.77±4.58	22.42±1.58	37.44±33.07	5.98±1.95	94.29±61.38	0.214±0.081
	L	26.32±4.17	22.58±2.03	57.8±46.16	6.85±2.58	111.53±57.8	0.259±0.091
VL	**R**	23.41±2.48	21.41±0.67	17.58±26.3	5.04±1.47	43.55±28.3	0.218±0.066
	L	23.42±2.29	20.99±1.85	25.86±36.43	5.41±2.09	51.92±36.48	0.232±0.085
VM	**R**	24.4±2.58	21.45±1.23	112.87±51.62	7.9±1.78	187.12±17.15	0.326±0.072
	L	23.69±2.21	21.23±1.31	103.7±56.53	7.43±2.14	190.46±44.75	0.317±0.094
BF	**R**	32.65±8.59	22.87±1.51	51.6±18.61	6.15±1.24	204.86±27.72	0.198±0.049
	L	40.62±10.09	23.83±2.36	70.32±27.56	7.31±1.96	187.53±25.27	0.190±0.058
ST	**R**	42.42±11.03	24.05±1.95	72.57±25.86	7.81±2.17	174.53±26.9	0.187±0.041
	L	42.5±10.77	23.76±1.88	76.01±26.18	7.83±2.45	164.78±29.71	0.187±0.046

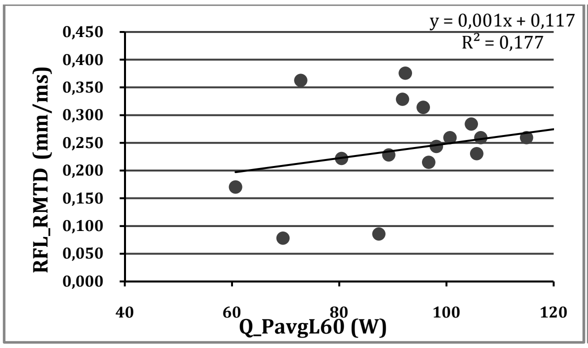
The graphics from 1 to 6show statistically significant correlation between the variables of voluntary and involuntary neuromuscular contractile properties. All correlations are at the level of statistical significance $p<0.05$. When the right leg is in question, significant correlations exist only between the demonstrated average power of knee joint flexors at a speed of 60˚/s and RMTD of muscle vastus lateralis ($r=0.42$) and semitendinosus ($r=0.41$). When the left leg is in question there is a correlation between the average power of extensor at a speed of 60˚/s and RMTD of the muscle rectus femoris ($r=0.42$) and Tc of the muscle vastus medialis ($r=0.41$). There is also a correlation in the left leg between the average powerof flexors at a speed of 60˚/s and Dm ($r=0.47$) or RMTD ($r=0.48$) of the muscle vastus medialis.



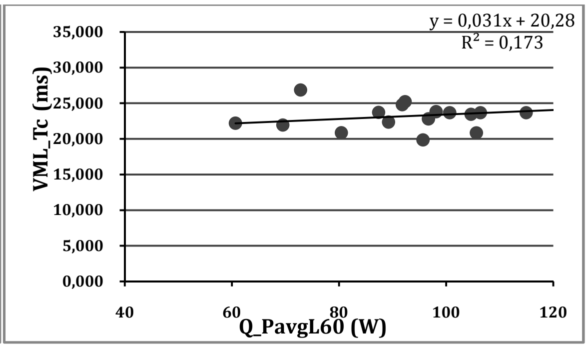
Graph 1: Relationship between the average flexor muscles powerof the knee joint of the right leg at a speedof 60˚/s and therate of muscle tension development of muscle vastus lateralisof the right leg



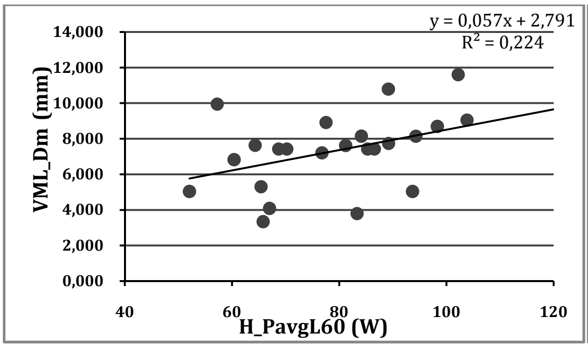
Graph 2: Relationship between the average flexor musclespowerin the knee joint of the right leg at a speed of 60˚/s and thetherate of muscle tension developmentof muscle semitendinosus of the right leg



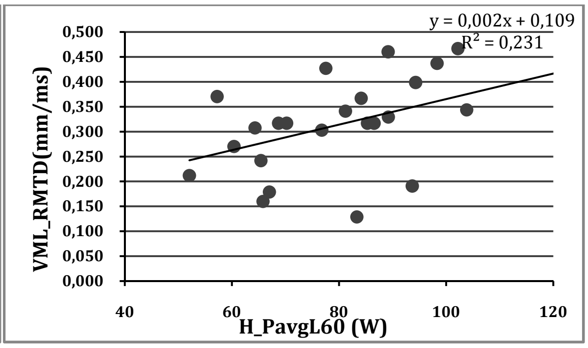
Graph 3: Relationship between the average extensormuscle powerin the knee joint of the left leg at speed of 60˚/s and rate of muscle tension developmentof muscle rectus femoris of the left leg



Graph 4: Relationship between the average extensormuscle powerin the knee joint of the left leg at speed of 60˚/sand the contraction time of muscle vastus medialis of the left leg



Graph 5: Relationship between the average flexor musclespowerin the knee joint of the left leg at speed of 60˚/s and maximal displacement of the muscle vastus medialis of the left leg



Graph 6: Relationship between the average flexor musclespowerin the knee joint of the left leg at speed of60˚/s and rate of muscle tension development of muscle vastus medialis of the left leg

DISCUSSION

The relation between the tests for the assessment of voluntary neuromuscular contractile properties measured by the method of isokinetic dynamometry and involuntary neuromuscular contractile properties measured by the method of tensiomyography in extensorand flexor muscles of knee joint was determinedin this study, on the sample of 24 adult, healthy and physically active men.

Table 1 presents the descriptive indicators of measured variables of voluntary neuromuscular contractile characteristics. We can see that the shown average power of flexor and extensor muscles of the knee joint increased at a rate of 120˚/s (66.75 %) which is an expected result considering that the reduction in speed or the increase in external load results in less manifestation of power and greater expression of strength. Extensor muscles of the right and left leg are stronger than flexors of the right and left leg(42.8%)which is also the expected result given that the extensor muscles of knee are the largest muscle group, and therefore have the biggest power. Extensor muscles of the right leg are stronger than the extensors of the left leg (10.7%) which is probably due to the fact that forthe majority of respondents the right leg isdominant. However, flexors of the left leg are stronger than flexors of the right one (4.9%), which is not common. Generally speaking, when the results of variables are to assess the power of flexor and extensor muscles of the knee joint, we can determine, when compared with the results of previous research, that this group showed a slightly higher power (5 %), which was expected considering that this group of respondents are physically active (Maffiuletti et al. 2007).

Table 2 shows the descriptive indicators of involuntary neuromuscular contractile properties of the muscles of legs on the basis of which we can conclude that the longest Tc refers to the semitendinosus muscle of the left leg, while the shortest Tcrefers to vastus lateralis muscle of the right leg.It has been shown that the Tc is associated with the type of the muscle fibers, and it is assumed that higher values indicate a predominance of the slow muscle fibers, and vice versa (Dahmane, Valenčič, Knez, & Eržen, 2001; Dahmane et al.2005). Delay time (Td) is the shortest in vastus lateralis muscle of the left leg and it is the longest in semitendinosus muscle of the right leg. As with parameter Tc, it turned out that Td has connections with a type of muscle fibers but also with fatigue (Dahmane et al. 2005; 2006), and it is also assumed that the vastus lateralis muscle has the highest percentage of fast muscle fibers while semitendinosus has the lowest percentage of fast muscle fibers in this group of respondents. Relaxation time (Tr) is the longest in the vastus medialis muscle of the right leg and lowest in vastus lateralis muscle of the right leg. Maximal displacement (Dm) is at least in vastus lateralis muscle of the right leg while it is the largest in the vastus medialis muscle of the left leg.It has been proven that this parameter is in conjunction with muscle tension, muscle mass and fatigue (Dahmane et al. 2001; Križaj et al. 2008; Pišot et la. 2008; Garcia-Manso, 2011). The sustain time (Ts) is the least at vastus lateralis muscle of the right leg and the largest in the muscles biceps femoris of the right leg, while RMTD is the largest in semitendinosus muscle of the right leg and the lowest is in vastus lateralis muscle of the left leg. It can be said that the results of this research in terms of the average value of the TMG parameters are in accordance with previous studies in this area which were made on a similar pattern and similar muscle groups (Zagorc, Šimunič, Pišot, & Oreb, 2010; Garcia-Manso et al. 2011; Rey, Lago-Penas, & Lago-Ballesteros, 2012; Garcia-Garcia, Cancela-Carral, Martinez-Trigo, & Serrano-Gomez, 2013; Alvarez-Diaz et al. 2014; Rodriguez-Ruiz et al. 2014; Loturco et al. 2015)

The graphics from 1 to 6 show statistically significant correlations between variables that describe the voluntary and involuntary neuromuscular contractile properties of the leg muscles. From a total of 8 variables for assessment of voluntary and 30 variables for assessment of involuntary neuromuscular contractile properties there are 6 statistically significant correlationsin the level of significance $p<0.05$. When right leg is in question there are significantcorrelations between the measured average values of the achieved flexor muscle power in the knee joint at a speed of 60˚/s and RMTD of vastus lateralismuscle ($r=0.42$; $p<0.05$) and semitendinosus ($r=-0.41$; $p<0.05$). Average flexor muscle powerat a speed of 60˚/s has a positive relationship with RMTD of vastus lateralis muscle while it has a negative correlation with RMTD of semitendinosus muscle, which means that increasing RMTD of vastus lateraliscauses decreasing flexor muscle powerat lower speeds, while the increasingRMTD of semitendinosus causes the power grows.This can be explained by the fact that the semitendinosus is a major flexor muscle of the knee joint, and thereforethepower depends on the speed of its contraction, while the speed of contraction of the vastus lateralis, which participates in the extension in the knee joint, although it is the counter-stabilizer of the knee jointflexion, does not contribute significantly to increasing power of flexors. In the left leg there is a correlation between the measured average extensor muscle power at a speed of60˚/s andRMTDof muscle rectus femoris ($r=0.42$; $p<0.05$) andTc of vastus medialis muscle($r=0.41$; $p<0.05$).Decreasing RMTD of musclerectus femoris($y = 0,0013x + 0,1179$) and increasingthe Tc of vastus medialis ($y = 0,0313x + 20,288$) causes the growthof average extensor muscle powerin the knee joint of the left leg. Also, in the left leg there is a correlation between the average power of flexors at a speed of 60 ˚/s andDm($r=0.47$; $p<0.05$) or RMTD ($r=0.48$; $p<0.05$) of the muscle vastus medialis. This means that the increasing Dm ($y = 0,0572x + 2,791$) and reducing RMTD (y =

0,0026x + 0,1091) of vastusmedialis causesgrowing flexor muscle strength of the left leg at low speeds.

As we can see, there is no consistent connection between the voluntary and involuntary neuromuscular contractile properties. A significant conection can be most observed between the parameters of RMTDand parameters of power.But thatconnection is the most often positive, indicating that with the increase in value ofRMTD also increases muscle power. Although there is a correlation between these parameters, we can conclude that, when we think of this group of respondents, the high speed of contraction will not contribute to greater muscle power in isokinetic conditions and vice versa. Similar situation is with the otherTMG parametersin which theconnection with the powerparameterswas found. Contraction time (Tc) and Dm have a positive correlation with the power parameters, which means that less Tcdoes not imply greater power in isokinetic conditions and vice versa. Previous research has found that less value of Dm indicates to better muscle tone (Dahmane et al. 2001; Križaj et al. 2008; Pišot et la. 2008; Garcia-Manso et al. 2011), therefore it would be logical that the relationship between this parameter and the average power is negative. Among other parameters TMG, Td, Ts, Trand power parameterssignificant statistical correlationswere not found.

It is interesting that significant correlations were found between TMG parameters and the average power of extensor and flexormuscles of the knee joint at speed of 60˚/s, at lower speeds and heavier external loads. This can point to the fact that the relationship between the voluntary and involuntary neuromuscular contractile properties is greater when voluntary contractile properties of the muscle are estimated in terms of increased external load, or when the component of muscular strength influence in a given movement is greater than the velocity componentof performing the same.Also, the greatest number of the correlationswas found between the knee jointflexor musclesaveragepower, especiallyof the left leg, and theTMG parameters. This information can point to the fact that the relationship between the voluntary and involuntary contractile properties of the muscle is higher in the smaller muscle groups, however explanation of this relation requires additional researches. The reason for the significantly larger number of correlations when the left leg is in questionis not known; however, we believe that this information is not important if we take into account the results of previous studies that point to the fact that, when we talk about theTMG parameters in football players, there is no difference between the dominant and nondominantleg (Alvarez-Diaz et al. 2014). When we talk about muscles, TMG parameters of vastus medialis muscle have the highest correlation with the parameters of power.

Results of this study are consistent with previous studies that dealt with a similar problem. Group of authors (Dopsaj et al. 2014) has determined that there is a significant correlation between TMG parameters, RMTD of vastus lateralis, medialis and rectus femoris and RFD, which supports the fact that RMTD has the highest correlation with voluntary muscle contractions. Another group of authors (Loturco et al. 2015) examined differences in the mechanical properties of the muscles between athletes from the sports of strength and power and endurance sports, and in that study, as well as in this one, there was no correlations between voluntary contractions (jumps) and all TMGparameters.They got the results that there is a moderate and statistically significant relationship between Tc (r=-0.61), Td (r=-0.65) of biceps femorismuscle, Td (r=-0.71) of rectus femoris muscle and a squat jump, moderate, statistically significant correlation was found between Td of rectus femoris muscle, and the countermovement jump (r=-0.72), while there was no relationship between Dm and jumps. However, among them there were found negative relations between Tc, Td and jumps, which can point to the fact that Tc, RMTD and Td have a greater impact on power manifested in isotonic or isoinertial conditions of muscle work.

CONCLUSION

We can conclude that, generally speaking, there was not found a consistent connectionin this work between voluntary neuromuscular contractile properties measured in isokinetic conditions, and involuntary neuromuscular contractilepropeties of legmuscles, measured by TMG. The highest correlation was found between the RMTD variable and knee joint flexor muscles average power at speed of 60˚/s. First of all, that indicates that RMTD as TMG parameter, has the highest correlation with voluntary contractile properties, but at the same time that involuntary contractile properties have a greater connection with the voluntary contractile properties when tested under conditions of lower speed or a larger external load. We can on the basis of the results of this study, conclude that TMG predictive values are weak compared to the appearance of power of the isokinetic conditions, and vice versa.

Further research are necessary in this field with a larger sample, in different muscle groups and, most importantly, with other tests measuring neuromuscular voluntary contractile properties. In future studies one should include tests to assess voluntary contractile properties of the muscles in isometric, isotonic and isoinertial conditions of muscle work in order to get a complete picture of relations between the voluntary and involuntary neuromuscular contractile properties, or relations between the tests for the assessment of voluntary andinvoluntary neuromuscular contractile properties.

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ANXIETY AS PREDICTOR OF SUCCESS AMONG YOUNG JUDOKAS

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SUMMARY

The main objective of this study was to assess the correlation of precompetition anxiety with success in the competition for younger cadet judokas. The sample consisted of 23 subjects, of average age 15±1.5 years. The sample of variables was composed of two predictor variables: heart rate at rest, heart rate immediately before the fight and three criterion variables: number of wins, the number of defeats, and placement in the competition. By calculating the difference between the pulse immediately after the fight and resting heart rate, a new variable was obtained, which can be considered as a quantification of physiological excitation in subjects. Linear correlation analysis showed statistically significant negative correlation between the number of wins and physiological excitation. It can be concluded that the subjects had more wins in the observed competition when the difference between resting heart rate and pulse just before the fight was lower.

Keywords: combat sport, success, psychological characteristics

INTRODUCTION

Anxiety is defined as an unpleasant feeling of unease, fear and tension followed by the activation of the autonomic nervous system (Petz, 2005). State of anxiety is defined as an emotional state characterized by physiological excitation and the experience of fear, dread and tension, and as a trait includes also a person's stable predisposition to often respond in such a way.One of the factors that significantly influences the success of the competition is the level of anxiety during the period preceding the competition. This is referred to as precompetitions' anxiety. Precompetition cognitive anxiety starts at a relatively high level and remains high and stable as the start of the competition approaches. In contrast, somatic anxiety remains relatively low until about 24 hours before the event, and then, with the nearing of the events, grows rapidly. When the competition begins somatic anxiety quickly disappears while cognitive state of anxiety varies during the competition depending on how the the probability of success / failure changes (Hardy et al. 1994). State of anxiety, which is a result of enviromental stimuliis associated with the increase in the excitation. Excitation is a neutral psychological phenomenon that can be associated with negative (anxiety) and positive (thrill) effects. Electrophysiological indicators of excitation are: electrocortical activity (electrical activity of the brain as measured by electroencephalogram - EEG), biochemical parameters (amount of released „stress" hormones in the bloodstream) heart rate, muscle tension (electrical potential of muscle measured using electromyography - EMG), respiration rate, sweating palms, galvanic skin response (increased sweating causes a drop in skin resistance) and blood pressure (Cox, 2005). The most common method of measuring anxiety as a trait and as a condition is the method of using a questionnaire paper-pencil type. Such measuring instruments are relatively simple to implement, inexpensive and non-invasive, but are still of questionable validity. Therefore, this study assessed anxiety, according to the author, with a more objective method of measuring heart rate variability (the difference in heart rate at rest than just before the fight). In sports in general, and especially in combat sports emotional stability is of great importance for success, so the assumption is that the respondents with less variability in the heart rate should achieve better results in competition. According to available data, there is only one study in judo, which was conducted in a similar manner which confirmed that the method of measuring heart rate variability is an objective method for assessing anxiety, and also that by using it, it is possible to discriminate the quality of judokas (Morales et al., 2013).

Therefore, the main objective of this study is to assess the correlation of precompetition anxiety with success in the competition for younger cadet judokas.

METHODS

Subjects

The sample consisted of 23 subjects (14 males and 9 females), of average age 15 ± 1.5 years, who competed in the regional championship for younger cadets held in Split 2015. Subjects were members of two judo clubs, and during the test were healthy and without injury.

Sample of variables

The sample of variables was composed of two predictor variables: heart rate at rest (HR1) and heart rate immediately before the fight (HR2) and three criterion variables: number of wins (W), the number of defeats (NL), and placement in the competition (PC). With the difference between the pulse immediately after the fight and resting heart rate HR2 – HR1, a new variable (HRA) was obtained, which is a form of physiological excitation in subjects. Heart rate was measured using a Polar S810 cardio tachometer.

Statistical analysis

For all variables basic descriptive parameters were calculated: arithmetic mean (M), standard deviation (SD), minimum (min) and maximum (max) result, and the asymmetry (skewness) and the curvature (kurtosis) of the results distribution. In order to establish a correlation between heart rate (anxiety) and criterion variables of success in judo, the Pearson linear correlation analysis was applied. Type one error was set at $\alpha=0.05$.

RESULTS

In table 1 parameters of descriptive statistics are presented.

Table 1. Descriptive parameters: Mean(M), Standard deviation (SD), Minimum (Min) and Maximum (Max), Skewness (Skew) and Kurtosis (Kurt).

	M	SD	Min	Max	Skew	Kurt
HR1	84.18	7.56	72.00	100.00	0.21	-0.51
HR2	120.73	14.53	96.00	140.00	-0.20	-1.37
HRA	36.55	11.47	16.00	52.00	-0.55	-1.00
NW	1.18	0.96	0.00	3.00	0.32	-0.75
NL	1.23	0.61	0.00	2.00	-0.14	-0.29
PC	4.32	2.50	1.00	8.00	0.45	-1.28

Legend: heart rate at rest (HR1), heart rate immediately before the fight (HR2), difference between the pulse immediately after the fight and resting heart rate (HRA) number of wins (W), the number of defeats (NL), placement in the competition (PC).

From Table 1 a relatively high dispersion of results in heart rate measures is observed, particularly in the variables HR2 and HRA, indicating different physiological responses to precompetition stress in subjects analyzed. Measures of shape and curvature of distribution indicate that there aren't any significant deviations from the normal distribution of results for all applied variables.Furthermore, in table 2 matrix of Pearson's coefficient of correlation are presented.

Table 2. Intercorrelation matrix (Pearson's coefficient of correlation) between predictors and criterion variables

	HRA
NW	-0.43[a]
NL	0.40
PC	0.31

Legend: difference between the pulse immediately after the fight and resting heart rate (HRA) number of wins (W), the number of defeats (NL), placement in the competition (PC). [a]$p<0.05$

From the table of intercorrelation statistically significant negative correlation (r = -0.43) between the number of wins and physiological excitation – anxiety can be seen. It can be concluded that the subjects had more wins in the observed competition when the difference between resting heart rate and pulse just before the fight was lower.

DISCUSSION

Previous studies have shown that there is no difference between the sexes in the physiological response of the body to the precompetition stress, therefore, in this work all subjects are observed together (Morales et al., 2013). Also, based on previous research it was not possible to compare the values of heart rate immediately before the fight because from the available data so far no one has measured. Average values of heart rate at rest (measured at 08:00 am on the day of competition in a relaxed supine position) are little higher than usual (HR1 = 84). Slightly elevated heart rate at rest is the consequence, most probably, of excitement for the upcoming competition. Pearson correlation coefficient (r = - 0.43) indicates a statistically significant negative correlation between the number of wins in the competition and differences in heart rate of the judoka. It can be concluded that the competitors whose heart rate increased less immediately before the fight acheived better success in the competition. Such result is logical and expected since the previous studies, no matter which method is used to determine precompetition anxiety, confirmed mutual negative correlation of the observed variables (Filaire et al., 2001, Salvador, et al., 2003, Morales et al., 2013)

Correlation analysis determined moderate, though not statistically significant, positive correlation between the difference in heart rate (HRA) and variables of number of defeats (NL) and placement in the competition (PC). Not finding a statistically significant association between these variables is also logical. On the one hand, number of defeats variable has lower dispersion results from the number of wins variable, which reduces the possibility of establishing a significant connection with the difference in heart rate. On the other hand, the placement in a competition depends significantly on the number of competitors in a category. So it is possible that a competitor without a win achieved a better result than someone who had for example two victories. Therefore, placement in the competition variable is not a fully objective indicator of competition efficacy of the subjects.

CONCLUSION

Heart rate, or precisely the difference between heart rate at rest and that just before competition is an objective indicator of anxiety in judo competitors. With this variable it is possible to successfully differentiate successful from less successful judoka at the age of 15 years. It is very helpful information because heart rate is relatively simple to measure, and it is an inexpensive and noninvasive method.

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THE EFFECTS ON DRY-LAND RESISTANCE TRAINING ON SWIMMING PERFORMANCE ON SWIMMERS AGED BETWEEN 10 TO 14 YEARS: A SYSTEMATIC REVIEW STUDY

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SUMMARY

This paper discusses the effects of additional strength and force training on the improvement of swimming performance in swimmers aged 10 to 14 years. The objective of the paper is to determine the effects of a program of additional strength training on dry land. The category observed in this study comprised swimmers aged 10-14 years. Additional strength training offers swimmers of this age group the opportunity to enhance their motor skills, explosive strength, speed and speed endurance, which in turn yields an improvement in swimming results. A search of electronic databases returned a set of studies which met the established criteria. The effects of the applied studies, lasting between six weeks and one year, and taking place in sessions between 20 and 60 minutes in duration, with a frequency of two to five times a week, indicate a significant improvement in swimming ability, sprint performance, stroke strength, stroke tempo, jump height, start time at 10m, absolute swimming speed, stroke frequency, turn time, stroke length and stroke efficiency. The scarcity of available studies into this problem affords researchers the opportunity for further research. The significance for sport and pedagogy lies in the effect of additional dry-land strength training in swimmers aged 10 to 14, which also warrants consideration regarding strategic planning for developing swimming performance with a view to improving swimming results.

Keywords: swimming, effects, strength, force, performance, dry-land resistance training.

INTRODUCTION

In swimming, as in other sports, there has always existed the effort to discover any factors which might influence the achievement of better results in competitions. The tendency for ever-increasing demands placed before swimmers in the course of training has also led researchers and other sports experts to continue with their research efforts in this area.

The objective of sports training is the increase in those anthropological characteristics and abilities which are crucial to succeeding in a particular sports discipline (Malacko 1991). The objective of training processes in swimming lies in effecting certain positive metabolic, physiological and psychological changes in the swimmer, which are in turn to enable the achievement of better results in competition (Maglischo 2003).

With a view to achieving maximal sports results, long-term swimming training comprises several distinct phases, in accordance with known principles regarding the growth and development of motor, functional and other anthropological abilities. According to the regulations of the Swimming Association of Serbia, a member of the International Swimming Association, swimmers are classified according to their age into the following competitive categories: 12 years of age and younger, 14-year-old and younger swimmers, up to 16 years old, up to 18 years old, and the absolute category. The first phase is basic or preparatory training, which lasts for two years and includes swimmers aged 10, 11 and 12 (Volčanšek, 2002). At this age children join the training process which includes nearly all components of the adult training program, and the swimming program itself has the characteristics of a transformative process with the aim of affecting the ability of young swimmers in terms of results improvement (Leko, 2001). The main objective of this phase is the gradual introduction of young swimmers into the training process that will develop their functional abilities by means of practicing swimming technique.

An optimal strength level is a requirement in any sport, and swimming is no exception in this regard (Newton, Jones, Kraemer & Wardle, 2002). Swimming presents the swimmer with specific requirements in terms of strength. These requirements are determined by the character and duration of dynamic effort in the course of competitive activity (Madić, Okičić, Rašović & Okičić, 2011). For successful realization of swimming technique, the swimmer needs the following types of strength: maximal strength, explosive strength and endurance in strength (Volčanšek, 1996; Kazazović, 2008).

Dry-land resistance training in young swimmers is aimed at increasing strength as part of enhancing the swimmers' general physical fitness (Volčanšek, 2002). The effects of strength training on young swimmers' swimming results can be tested through scientific comparisons between swimming results achieved when resistance training is included and results achieved with no additional strength training. The results of such studies are significant for training practice and practical work during the training process with young swimmers.

METHODS

In order to collect the studies to date into the effects of applying a program of resistance training in swimmers aged 10 to 14 years, the following electronic databases were searched: PubMed /Medline, PEDro, SCIndeks, DOAJ, Google Scholar. The search was limited to papers spanning the period between 2009 and 2014. The following key words were used when searching the databases: swimming, effects, strength, force, performance, dry-land resistance training. Then the retrieved titles, abstracts or full texts were read and analyzed. For a study to be included in the final analysis, the following two criteria had to be met: the subjects had to be aged between 10 and 14 years, and they also had to be engaged actively in swimming training. The studies which met these criteria were then analyzed and presented according to the following parameters: reference (author's first initial and year the study was published), subject sample (participants' age, number, and subgroups), the applied program of physical exercise, program duration, results obtained in the study, and study contribution.

RESULTS

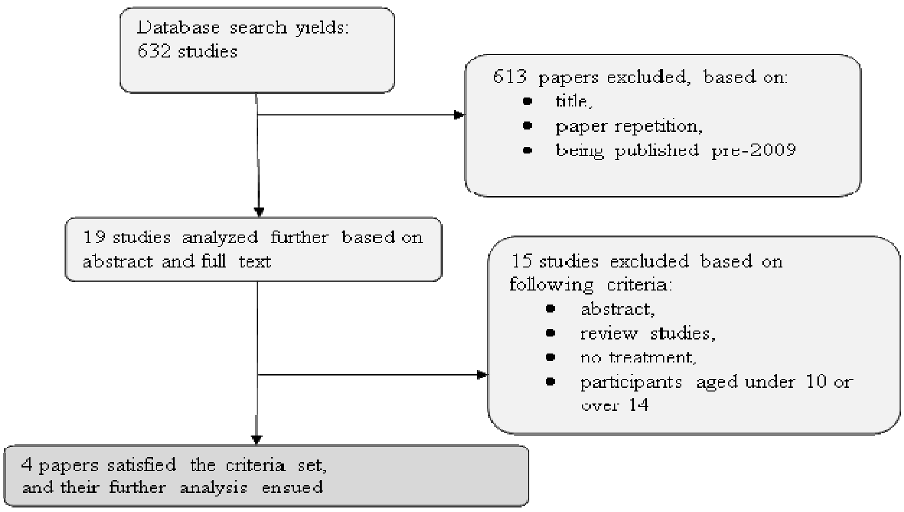

Figure 1. A statistical representation of retrieved studies.

The process of collecting, analyzing, and eliminating the studies retrieved is presented in Figure 1. A total of 632 papers were identified via the keywords. The number of studies immediately excluded based on title, paper repetition, and period when published (earlier than 2009) was 613, whereas 19 studies were selected for further analysis. Further analysis excluded another 15 papers based on several criteria: abstract revealing these were systematic review studies, as well as the age range of participants in the study being inadequate (younger than 10 or older than 14 years of age).

The remaining four papers satisfied the criteria set, namely: papers published between 2009 and 2014, participants in the study being competitive swimmers aged 10-14, and the study including both a control and an experimental group.

Reference	Study design	Sample (age, number of participants)	Program	Program duration and exercise intensity	Tests	Study results
Nuno et al. (2010)	Experimental study	A-12,08±0,76 E=14; C=11 (both sexes)	E – In-water training and dry-land strength training. C – In-water only training	8 weeks, E – In-water training 6 times per week, 90mins, plus dry-land training twice per week, 20mins. C – training 6 times per week, 90mins.	(6RM) bench press, CMJ test, Ball throwing (1kg,3kg), ErgojumpDigitime 1000 Digest Finland, Doppler radar gun (Sports Radar 3300, Sports Electronics Inc., Draper, Utah, USA), Golfinho Sports MC 815(Aveiro, Portugal).	↑Swimming abilities (p< 0.01, p< 0.05), CMJ test (p < 0.01), (6PM) bench press (p < 0.01-p < 0.05), Ball throwing (1kg p< 0.05,3kg p< 0.01) compared to control group (The first significance parameter within test indicates final testing, and the second refers to the testing result 6 weeks after final testing).
Okičić et al. (2010)	Experimental study	A-12±2 N - 30 (male)	E – In-water and dry-land training C – in-water training	6 months, 5 times/week, 60-80mins, plus resistance training 5 times/week, 30-40mins.	ST_TIME, TURN5_5, SPE_10M, TEMPO, LENSTRO, STROSTRE, FREQ, CRAWL100	↑TEMPO, LENSTRO, CRAWL100
Potdevin et al. (2011)	Experimental study	A - 14 N -23 swimmers divided into experimental and control group	E – standard swimming training, plus plyometric training C – standard swimming training	6 weeks' program duration. E – swimming training 5.5hours/week (2x2hrs and 1x1.5hr), and 2 plyometric sessions. C – swimming training, 5.5hrs/week	Type TANITA, 'Ergojump' (Junghans GMBH – Schramberg, Germany), CMJ test, SJ test, Speed sensor (Scaime, type PT 9301), Swimming tests (50-м и 400м).	↑CMJ (p<0.01); SJ (p<0.01); glide speed (p<0.05); Swimming tests 50-m and 400m (p<0.05) in favor of the experimental group.
Pešić et al. (2013)	Experimental study	A - 10 to 13 years N - 30	Swimming training and dry-land training for improving strength and specific motor ability.	One year, with a frequency of swimming practice 6 times per week, 60-100mins, and dry-land training 3-5 times per week, lasting 60mins.	ST10,SS10, SF, TT, SL,SE, BRE100 by means of the following electronic devices: 'Alge swim', Austria, Video camera (JVC Everio GZ-MG365BU), and the software 'Kinovea', 0.8.15	↑ improvement across all parameters, significance at level (P>0.01)

A – participant age; N – number of participants; ↑ - increase in significant differences, i.e., changes; E – experimental group; C – control group; Chronometer ('Golfinho Sports MC 815', Aveiro, Portugal) time-measuring device; (6RM) bench press – six bench presses on level bench; CMJ test (counter-movement jump), vertical jump test; Ball throwing (1kg ,3kg), medicine ball throwing test; Ergojump Digitime 1000 Digest Finland – trigonometric surface for measuring vertical jumps; Doppler radar gun (Sports Radar 3300, Sports Electronics Inc., Draper, Utah, USA) instrument measuring medicine ball (1kg and 3kg) speed; ST_TIME – time for first 10m section swum; TURN5_5 – turn time 5+5m; SPE_10M – swimming time at 10m; TEMPO – swimming tempo; LENSTRO – length/stroke; STROSTRE – stroke strength; FREQ – stroke frequency; CRAWL100 – 100m crawl swimming speed; Impedancemetric balance scale (type TANITA) device for assessing body weight and fat; 'Ergojump' (Junghans GMBH – Schramberg, Germany) device used for vertical jump testing; Test SJ (Squat Jump) vertical jump test with initial knee joint position 90°; Speed sensor (Scaime, type PT 9301) speed measuring sensors; Swimming tests (50-m and 400m) 50m and 400m crawl swimming speed tests; ST10 – start time up to 10m length swum; SS10 – 10m absolute swimming speed; SF – stroke frequency; TT – turn time 5+5m; SL – stroke length; SE – stroke efficiency; BRE100 – 100m breaststroke time; 'Alge swim' (Austria) electronic device for measuring time; Video camera ((JVC Everio GZ-MG365BU); software 'Kinovea', version 0.8.15 (video material processing software, based on which specific motor ability parameters were established).

DISCUSSION

Using a participant sample of active swimmers aged between 10 and 14 years, of both sexes, the treatment consisted of additional dry-land resistance training in the duration of six weeks to one year, in sessions lasting between 20 and 60 minutes, and a frequency of two to five sessions per week. Depending on the length of the session, the training level was between medium-high and submaximal intensity. Strength training comprised a program of exercises including plyometric exercises performed in 2-6 sets, with 5-10 repetitions each, exercises for strengthening the abdominal muscles (various resistance exercises for increasing abdominal strength, using medicine balls weighing 1-3kg or with no added weight), exercises for strengthening the chest, arms, and shoulders, also performed with added weight (2-3 sets, 6-8 repetitions each), as well as calisthenics.

The focus was on the effect of additional strength training on swimming performance. To assess the program's effects, comparisons were run between the control and experimental groups, as well as between the initial and final tests, using the following instruments: Chronometer ('Golfinho Sports MC 815' Aveiro, Portugal), (6RM) bench press, CMJ test, Ball-throwing test (1kg, 3kg), ST_TIME, length swum; TURN5_5 - turn time 5+5m; SPE_10M – swimming time at 10m; TEMPO-swimming tempo; LENSTRO - length/stroke; STROSTRE – stroke strength; FREQ – stroke frequency; CRAWL100 – 100m-crawl swimming speed; Impedancemetric balance scale (type TANITA), a device for measuring body weight and fat; 'Ergojump' (Junghans GMBH – Schramberg, Germany), a device used for vertical jump tests; Test SJ , Speed sensor (Scaime, type PT 9301), Swimming tests (50m and 400m), ST10 - start time up to 10m, SS10 – absolute swimming speed, 10m absolute swimming time, SF – stroke frequency, TT – turn time 5+5m, SL – stroke length; SE – stroke efficiency, BRE100 – 100m breaststroke time; 'Alge swim' electronic device for measuring time, video-camera (JVC Everio GZ-MG365BU), software 'Kinovea', version 0.8.15.

The parameters that were measured using the above tests and instruments, comparing the initial and final tests and comparing the control and experimental group, indicated statistically significant differences in the form of enhanced results across all tests, in the range $P=0.00$ to $P<0.05$. The results obtained indicate improvements in the following: swimming ability, sprint performance, stroke strength, stroke tempo, jump height, start time up to 10m, absolute swimming speed, stroke frequency, turn time, stroke length, and stroke efficiency.

CONCLUSION

The range of studies reviewed indicates a scarcity of information established through scientific research into the effects of additional dry-land resistance training in swimmers aged 10 to 14, in turn indicating a need for further research into this area in the future.

This paper contributes to a better understanding of the significance of the effects of additional dry-land resistance training on swimming performance. It is aimed at coaches and swimmers in order to help them set the optimal strategy for increasing physical fitness in preliminary and principal competitions for the age category analyzed. Some findings, however, may also prove useful for designing a training model aimed at developing those abilities that have the greatest influence on achieving the planned final result in a specific phase at the beginning of the swimmers' career in sport.

The results obtained in this study should also facilitate the application of appropriate resistance-training activities that have a considerable influence on swimming speed and the improvement of results.

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APPLICATION OF MOTORIC MEASURING INSTRUMENTS IN THE PROCESS OF TALENT IDENTIFICATION FOR ARTISTIC GYMNASTICS

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SUMMARY

The aim of research was related to the systematization of all available batteries of motoric measuring instruments used in the identification of talents in artistic gymnastics and based on what was given answer to the questions: which motoric areas are covered in this process and in which percentage are covered. Based on obtained results a hypothetical equation specifications of motor skills is set in the process of identifying talents in artistic gymnastics, which includes the following relations: power (average 45%), flexibility (average 32%), coordination (average 10%), balance (average 7%) and speed (an average of 6%). Endurance was resolved only in one case, a space of precision is not generally praised for the identification of talents in artistic gymnastics.

Keywords: identification talent, artistics gymnastics, measuring instruments, selection

INTRODUCTION

Breaking into the European and World top today is much harder than the one or several decades before. Getting closer to the top and overcome existing sports results can be achieved only by specially selected people. Because of this, characteristic feature of present period in the development of sport becomes a comprehensive, scientifically-based talent search, which of them are able to bear the high tempo of training load. Results of research activities in resolving the question of identification systems for talented young athletes are becoming an essential element that is increasingly stands out in explaining the very rapid development of sports results in the world.

In modern theory and practice in order to successfully manage the process of identifying talents in gymnastics, various measuring instruments are using. Motor skills are latent character and therefore can not be measured directly, but in an indirect way. The measurement of motor skills can be described as a very complex task, because of many internal factors, as well as the imperfections of the existing measuring instruments.

Application and measurement of motor skills in process of identifying talents for artistic gymnastics is very important but insufficiently explored topic. This article will attempt to answer some questions in the mentioned process. It will point out the significance and direction of measurement of motor abilities in the first stage of identifying talents for artistic gymnastics.

Researches on this subject are rare. Prasas (1999) deals with the systematization of researches in artistic gymnastics, where he lists all the available researches which are dealing with some problem in artistic gymnastics. Velickovic (1999) has collected and researched applicative value of the coordination tests that are in use during the identification of talents in artistic gymnastics, on a sample of 228 boys, aged seven. The author has determined metric characteristics of all 19 tests of coordination and on the basis of the research results suggested a wider set of eight measuring instruments for determining the ability of coordination. Klentrou (1993) gave a comprehensive review of the literature, which refers to the battery of tests applied in the identification of talents in artistic gymnastics, namely: Vankov (1978); Kozlov & Koljukov (1979); Salmela, Regnier & Proteau (1979); Rozin & Mukhambetov (1980); Webber (1982); Carzola & Margueritat (1986);

Radoulov (1986); Rozin (1986); Salt (1987); Hartlei (1988); Risack, Plum and Sturbois (1988); Poelvoorde & Levarlet-Joie (1990). Mentioned author analyzed the common characteristics of all batteries, as appropriate, unique and original characteristics of the individual batteries. After careful consideration of the existing battery, Klentrou (1993) concludes that the following tests are usually represented in the initial detection of talents in artistic gymnastics: height, weight, side split, 20m sprint, lifting legs, long jump and agility tests. As expected, the range of tests commonly included in the final battery of tests in selection is more comprehensive and includes the following tests: height, weight, body proportions, all three splits, bridge, flexibility in the shoulder joint, 20m sprint, chin-ups, long jump, a series of consecutive jumps and assessment of balance.

The aim of this research is to systematize all available batteries of motor measuring instruments used in the identification of talents for artistic gymnastics and based on that answer the questions: which are the motor areas covered in this process and in which percentage are they covered. Based on obtained results can be set a hypothetical equation of specifications of motoric skills in process of identifying talents for artistic gymnastics.

Based on the obtained findings will be given a proposal of the battery of motoric measuring instruments which would be the most appropriate for use in the practice of identifying talents for artistic gymnastics in Republic of Serbia.

METHODS

The research method implies selection method, descriptive method and classification of studies. With selection method were selected papers that are available in electronic and written form, which involved the research of talents identification in artistic gymnastics. By descriptive method selected works were analyzed, summarized and included in this study. Classification of work was done on the basis of the subject of research in papers. For the collection of previous researches on the application of motoric measuring instruments in selection process for artistic gymnastics searched by the following electronic databases: PubMed / Medline, Pedro, SCIndex, Dean, as well as all available literature in writing. Found titles of researches, abstracts and full texts were then read, analyzed and classified.

RESULTS

The study included a total of 24 batteries of measuring instruments used in the identification of of talents for artistic gymnastics. A total of 13 countries covered by this study, of which three are former (Soviet Union, Yugoslavia, Czechoslovakia) and 10 of the existing (Russia, Bulgaria, USA, Canada, Brazil, Czech Republic, Greece, Serbia, Slovenia, Bosnia and Herzegovina). Respected were batteries of measuring instruments from site "Topend sports" where they were also found useful information related to the selection of gymnasts and measuring tool batteries recommended by the International Gymnastics Federation (FIG) when it comes to identification of talents in artistic gymnastics. The analyzed period covers a range of 45 years, from 1969 to 2014.

The number of measuring instruments per battery ranges from a minimum of six (Topend sports) to a maximum of 16 tests (SSSR 1982), while the average value is 11 measuring instruments per battery (Table 1). The most commonly used batteries are of eight (BH 1990, the FRY in 1993, USA 2011, USA 2014) and 10 measuring instruments (RUS 2005 BUL 1983, 1987, CZH 2013).

Table 1. – Number of measuring instruments (MI) per batteries

STATE	YEAR	NUM. MI	STATE	YEAR	NUM. MI
SSSR	1969	15	BH	1990	8
SSSR	1972	13	FSFRY	1977	15
SSSR	1982	16	FSFRY	1985	12
SSSR	1983	14	FRY	1993	8
RUS	2002	16	BRA	2007	15
RUS	2005	10	USA	2011	8
BUL	1971	9	USA	2012	11
BUL	1975	11	USA	2014	8
BUL	1983	10	CZH	2013	10
BUL	1987	10	KAN	2013	14
CZH	1979	7	TPS	2014	6
GRE	1987	9	FIG	2009	14
SLO	1990	7			

MIN – 6; MAX – 16; MEAN – 11; MOD – 8 and 10

Table 2 shows the ratio of measuring instruments in batteries per motoric abilities.

Motoric abilities that are respected in the selection process for artistic gymnastics are:

strength (STR), speed (SPE), flexibility (FLX), coordination (COR), balance (BAL) and endurance (END) quite rare.

Table 2. Number of measuring instruments per motoric areas

STATE	YEAR	STR	FLX	COR	BAL	SPE	END
SSSR	1969	4	5	2	3	1	0
SSSR	1972	3	5	4	1	0	0
SSSR	1982	6	5	1	3	1	0
SSSR	1983	5	5	4	0	0	0
RUS	2002	6	3	3	3	1	0
RUS	2005	5	4	1	0	0	0
BUL	1971	5	3	0	0	1	0
BUL	1975	4	4	2	0	1	0
BUL	1983	4	3	1	1	1	0
BUL	1987	4	3	2	1	0	0
CZH	1979	4	3	0	0	0	0
GRE	1987	4	3	1	1	0	0
SLO	1990	3	1	2	0	1	0
BH	1990	5	1	1	1	0	0
FSFRY	1977	6	6	1	1	1	0
FSFRY	1985	5	4	1	1	1	0
FRY	1993	4	3	1	0	0	0
BRA	2007	6	5	1	2	1	0
USA	2011	4	2	0	1	1	0
USA	2012	5	3	1	1	1	0
USA	2014	3	3	0	1	1	0
CZH	2013	4	4	1	0	0	1
KAN	2013	9	4	0	0	1	0
TPS	2014	4	1	0	0	1	0
FIG	2009	7	6	0	0	1	0
	MIN	3	1	0	0	0	0
	MAX	9	6	4	3	1	1
	RANG.	6	5	4	3	1	1
	MEAN	5	4	1	1	1	0
	MOD	4	3	1	0	1	0

DISCUSSION

As confirmed by research of Klentroa (1993) in this study it was also concluded that all analyzed gymnastic schools respected the measurement of motor skills as an important parameter in the selection process for artistic gymnastics (Table 1). Considering that, during the initial selection process, should be measured large number of candidates is justified to use batteries that contain up to 10 measuring instruments. This achieves a high efficiency of measurement, but on condition that it does not disturb the quality of the evaluation of candidates.

Motor skills that are respected in the selection process for artistic gymnastics are: strength, speed, agility, coordination, balance and very rare endurance (Table 2). A similar constatation is in the case of research Fadeva (1993, taken from Klentroa, 1993).

In the case of this study was calculated the percentage ratio of representation of specific motor abilities on the basis of the data presented in Table 2. It is obvious that the space of power is paid the most attention (average 45%), followed by flexibility (average 32%), coordination (average 10%), balance (average 7%) and speed (an average of 6%). Endurance was resolved only in one case, a space of precision is not generally praised for the identification of talents for artistic gymnastics.

Coaches traditionally assume that the muscle strength is an important component in identifying talents in artistic gymnastics. This assumption is supported by studies that have shown a high correlation between tests of strength and level of sporting achievement in artistic gymnastics (Radoulov 1986; taken from Klentrou, 1993).

The results indicate that the estimation of power is respected in each of the analyzed batteries and that is dominant in the selection process for artistic gymnastics (Table 2). On average five measuring instruments belong to this area, which is an average of 45% over the entire battery of tests. In some cases as much as 67% of the tests belong to the field of strength, and some batteries are used as much as nine tests for evaluation of various manifestations of strength (Canada). The most frequent (mode) is to apply four measuring instrument of strength, respectively the most frequently is forty percent (40%) ratio of strength and all the other tests within a single battery.

In the area of strength are treated the following sub areas: repetitive, static, explosive strength and maximum strength measured on the dynamometer. The most common and most widely used are measuring instruments for assessing the repetitive strength at an average of three tests per battery (59%). Klentrou (1993) also notes that most of the batteries of tests, include assessment of local muscle endurance – repetitive strength. This study confirms that the group of these tests are most commonly treateing arm and shoulder belt (on average 70% of the total area of strength per battery - two tests per battery), and then trunk (on average 30% of the total area of strength per battery - usually one test per battery). Repetitive strength of legs, are very rarely applied. There was a single case (FIG, 2009) and that is test for the evaluation of repetitive strength of knee extensors (standing up on one leg). The second representation within the strength is area of explosive strength. On average 23% represent tests for assessing these performance relative to the entire space of strength per battery. The most commonly applied is one test per battery (19 cases - 76%) and those are mainly tests that specifically measures the explosive strength of the lower extremities (23 cases - 92%). Most applied test is the long jump (20 cases - 80%), and much less applied test is jump up (5 cases or 20%). Previous researches suggests that the test long jump is most applied for measureing these skill (Vankov, 1978; Rozin, 1979;. Salmela et al, 1979; Radoulov 1986; Bajo, 1987 Sol 1987; Poelvoorde & Levarlet-Joie, 1990 ; Fadeev, 1993 - taken from Klentrou, 1993). The third one within the strength is space of static strength, defined as the ability of the maximum time endurance of specific body position that opposes the force of gravity. Previous researches indicates that assessment of static and dynamic strength are an important parameter in identifying talent (Rozin and Mukhambetov 1980, taken from Klentrou, 1993). In this study, an average of 17% goes on the evaluation of static strength in relation to the total area of strength. In 12 cases the static strength is generally not assessed (about half - 48%), while in 13 cases (52%) static strength is estimated by one (8 patients - 32%) or more measuring instruments (5 cases - 20% - 2 to 7 tests per battery). Only in case of the battery of Canada in 2013 was applied seven tests for evaluation of static strength.

Next motor ability that always respects and that is, after strength, mostly deal with the selection process in artistic gymnastics is flexibility (Table 2). Flexibility is also considered as an important aspect of discovering talents (Radoulov 1986; taken from Klentrou, 1993). Estimates of both active and passive flexibility are considered important (Salmela et al., 1979; Rozin & Mukhambetov 1980, Bajo, 1987 - taken from Klentrou, 1993). In this study, an average of four measuring instruments is used to assess these skills, respectively 32% in relation to the entire battery. A maximum of six tests of flexibility within a single battery was identified in battery of FIG. Most often used are three measuring instrument or the most common is thirty percentage (33%) ratio of flexibility tests and all the other tests within a single battery. Previous studies (Klentrou, 1993) which show that the flexibility is usually assessed in the shoulder joint, hip joint, hamstring, loin part, the joints of hands and feet, to a large extent confirms the statements from this research.

Assessment of motor skills such as coordination, balance and speed gives less attention. Mainly a single measuring instrument is used to measure these skills, or 6 to 10% over the entire battery of tests (Table 2).

Findings from previous studies are quite consistent with the results of this study (Klentrou, 1993). In this study, in 28% of cases coordination is not measured in the selection, with the justification that this capability should be evaluated through speed and quality of mastering the elements of gymnastics programs (Table 2). In 72% of cases the measurement of this motor ability is represented in batteries for the selection, out of which in 44% of cases, the coordination only measures by one measuring instrument, and in 28% of cases with two to four measuring instrument. In the area of coordination mostly respected is sub area - the speed of realization of motor tasks, then, the accuracy of complex motor tasks. In only one case was recorded a test for the evaluation of coordination in rhythm (test - drumming hands), while in the other cases highlights is on the artistic gymnastic effect in the selection process for artistic gymnastics (battery Yugoslavia 1977).

In the case of balance, in 44% of cases (11 batteries) this ability is not measured in the selection (Table 2). In other cases (56% - 14 batteries) this ability is measured by one measuring instrument (40%) and with two to three measuring instruments

(16%). As in previous researches (Peltenberg, Erich, Bernink and Huisveld 1982, Rozin 1986;. Risack et al, 1988; Poelvoorde & Levarlet-Joie, 1990 - taken from Klentrou, 1993), two components of the balance are assessed as important in the phase of discovering talents: static balance (36%) and dynamic balance (28%) cases.

In the case of speed, 64% of the cases (16 batteries) are measured with a single measuring instrument, while in 36% of cases is not assessed in the selection for artistic gymnastics (Table 2). It is not recorded use of more than one test per battery when it comes to the assessment of this ability. In 60% of cases is measured running speed at 20m (15 batteries), and only in one case the measured is frequencyof hand movement (test - Taping hand - GB 1990). Speed at 20m is also the mostly used test when it comes to the analysis of previous researches (Klentrou, 1993).

Endurance is generally not assessed in the selection for artistic gymnastics, probably from the security reasons when it comes to beginners and children (Table 2). Previous researches do not mention measuring of this capability (Klentrou, 1993). Namely, it is not advisable in work with beginners and children to use measuring instruments that require the submission of stress in a longer time interval. Only in one case was applied test of endurance and that is in the case of batteries the Czech Republic (2013), where is applied Jaciko test (Cuberek, Jakubec, the Hulk and Botek 2011).

There have been no measuring instruments used to evaluate accuracy. Accuracy is often defined as motor ability of accurately targeted and dosed movements and motions. Some measuring instruments used in the selection, intentionaly measures precision and accuracy of movement, but they are classified as part of the measuring instruments which are used to assess coordination abilities. However, as in previous researches (Klentrou, 1993), the precision as the ability of shooting or targeting to hit some static or moveable target, which is located at a certain distance, in general is not respected in the selection process for artistic gymnastics.

CONCLUSION

From the results obtained and presented in this review study can be hypothetical set an equations of specifications of measurement of motor skills in the process of identifying talents for artistic gymnastics and from that perform the most important tests for selection in artistic gymnastics:

- More detailed equations, which presupposes the use of 12 tests (most commonly used and presented batteries):

STRENGTH 45% ((5 tests - pull-ups (num), push-ups (num), lift the leg to the grip (num), long jump (cm), endurance of L-sit in hang (sec.)) + FLEXIBILITY 32% ((4 tests - deep forward bent (cm), head split (cm), “iskret” with stick (cm), Bridge (cm)) + COORDINATION 10% ((1 test - backward polygon (sec)) + SPEED 6% ((1 test - 20m sprint (sec)) + BALANCE 7% ((1 test - turn around the longitudinal axis - walking on the balance beam (ratings)).

- More economical equation is the one which assumes the use of the battery of eight tests:

STRENGTH 50% ((4 tests - pull-ups (num), push-ups (num), long jump (cm), endurance of L-sit in hang (sec.)) + FLEXIBILITY 38% ((3 tests - deep forward bent (cm), “iskret” with stick (cm), bridge (cm)) + SPEED 6% ((1 test - 20m sprint (sec)).

When applying the eceonomical battery, coordination should be accompanied through a artistic gymnastic effect (speed and quality of the adoption of elements from artistic gymnastics), and balance should be followed if it’s necessary.

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110 M HURDLE RUNNING SPEED DYNAMICS

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SUMMARY

The aim of the following study is to research in details running speed dynamics (using running time splits) in the discipline 110 m hurdles for the age groups youth, junior and men. In total 111 case were analyzed useding a video analysis and statistical methods (variance and corelation analysis). The presented data analysis will be in use for both theory and practise of hurdle running. Also the revealing of running speed dynamics gives new details and understanding of studied discipline.

Keywords: 110 m hurdles, youth, junior, men

INTRODUCTION

Among hurdle running discipline one of most interesting and spectacular is the 110 m distance. The hurdlers must clear 10 hurdles (the distance between the start line and first hurdle is 13,72 m, distance between hurdles is 9,14 m, and from the last 10th hurdle to the finish line distance is 14,02 m). The height for the different age groups are as follows: youth – 91,4 cm, junior – 99,1 cm, men – 106,7 cm. The ages for the different groups are as follows: youth – under 18 years, junior – under 20 years, and men – over 20 years [IAAF Competition rules].

There are many developments regarding speed pace (or speed dynamics) over the internet [1, 2, 3, 4], or like those presented by Brent McFarlane in his book "The science of hurdling". But none of the presented above are revealing in details speed dynamics change in different age groups and different level of sports qualification. This motivated us to conduct the following study.

METHODS

The aim of the following study is to reveal in details the speed dynamics in the 110 m hurdle discipline for the age groups youth, junior and men. Also an interest for us are the interrelations between different parts of the distances and the sport results. In order to achieve our aim we analyzed in total 111 cases (20 youths, 42 juniors and 49 men). The analyzed competition are part of Bulgarian Athletics Federation (BAF) – 8 competitions, Association of Balkan Athletics Federation (ABAF) – 1 competition and European Athletics (1 competition) official sports calendars.

For conducting the following study we recorded all mentioned competitions with video camera (Nikon D5100 with 18-55 mm VR lens, FHD resolution) and with the help of Kinovea 0.8.24. software (free for download and use) we analyzed the intermediate times for clearing each hurdle. For data processing we used SPSS 19.0 and Microsoft Office Excel 2013. We applied variance and correlation analysis. We analyze speed based on intermediate times – faster time responds to higher speed levels.

RESULTS AND DISCUSSION

Table 1 presents variance and correlation analysis of study data divided by age and results groups as follows: youth (under 17 sec.), junior (under 15 sec. and over 15 sec.) and men (under 14,50 sec. and over 14,50 sec.). All intermediate speed values (avg.). Figure 1 presents the variance analysis data for all age and result groups. The table also includes information about the correlation between intermediate times and final result.

Table 1. 110 m hurdle running speed dynamics – variance and correlation data.

results	age group	n	respondents number	Sport Result (SR)	Respondents age	Intermediate start - 1st hurdle	Intermediate 1st - 2nd hurdle	Intermediate 2nd - 3rd hurdle	Intermediate 3rd - 4th hurdle	Intermediate 4th - 5th hurdle	Intermediate 5th - 6th hurdle	Intermediate 6th - 7th hurdle	Intermediate 7th - 8th hurdle	Intermediate 8th - 9th hurdle	Intermediate 9th - 10th hurdle	Intermediate 10th hurdle - final
under 17 sec.	Youth	15	10	SR Correlation		0,590	0,792	0,856	0,919	0,960	0,954	0,957	0,912	0,484	0,659	0,602
		Variance	X min	14,57	15	2,82	1,11	1,10	1,12	1,14	1,09	1,11	1,13	1,11	1,12	1,44
			X max	16,72	17	3,06	1,32	1,29	1,40	1,32	1,32	1,33	1,34	1,63	1,91	1,91
			R	2,15	2	0,24	0,21	0,19	0,28	0,18	0,23	0,22	0,21	0,52	0,79	0,47
			X avg.	15,58	16	2,90	1,22	1,19	1,21	1,23	1,19	1,21	1,22	1,27	1,31	1,70
			S	0,773	0,676	0,074	0,059	0,063	0,087	0,063	0,085	0,077	0,076	0,135	0,196	0,129
			V	4,96	4,17	2,57	4,83	5,25	7,21	5,15	7,14	6,31	6,21	10,64	14,95	7,59
under 15 sec.	Junior	16	5	SR Correlation		0,547	0,786	0,73	0,895	0,564	0,934	0,558	0,757	0,709	0,752	0,028
		Variance	X min	13,98	18	2,52	1,08	1,10	1,04	1,08	1,04	1,08	1,08	1,10	1,09	1,47
			X max	14,9	19	2,84	1,19	1,22	1,18	1,20	1,21	1,16	1,20	1,24	1,22	1,74
			R	0,92	1	0,32	0,11	0,12	0,14	0,12	0,17	0,08	0,12	0,14	0,13	0,27
			X avg.	14,54	18,6	2,70	1,13	1,14	1,12	1,12	1,12	1,13	1,14	1,16	1,16	1,61
			S	0,293	0,512	0,094	0,035	0,038	0,039	0,036	0,044	0,029	0,031	0,035	0,032	0,072
			V	2,02	2,76	3,48	3,08	3,35	3,44	3,20	3,88	2,55	2,75	3,01	2,74	4,48
over 15 sec.		26	17	SR Correlation		0,679	0,764	0,826	0,833	0,900	0,119	0,927	0,894	0,941	0,914	0,712
		Variance	X min	15,24	16	2,60	1,16	1,16	1,17	1,15	1,13	1,18	1,20	1,23	1,24	1,57
			X max	18,93	19	3,16	1,36	1,40	1,42	1,46	2,25	1,48	1,80	1,76	1,96	2,24
			R	3,72	3	0,56	0,20	0,24	0,25	0,31	1,12	0,30	0,60	0,53	0,72	0,67
			X avg.	16,43	18	2,88	1,25	1,27	1,27	1,28	1,32	1,30	1,33	1,36	1,39	1,83
			S	0,908	1,033	0,123	0,050	0,061	0,067	0,076	0,203	0,074	0,122	0,123	0,163	0,150
			V	5,53	6	4,28	4,00	4,77	5,29	5,94	15,33	5,68	9,20	9,05	11,79	8,22
under 14,50 sec.	Men	10	10	SR Correlation		0,822	0,597	0,884	0,872	0,794	0,863	0,746	0,819	0,631	0,284	0,129
		Variance	X min	13,64	21	2,60	1,02	1,04	1,00	1,06	1,02	1,03	1,04	1,06	1,10	1,47
			X max	14,47	30	2,80	1,16	1,12	1,12	1,12	1,14	1,14	1,16	1,16	1,16	1,57
			R	0,83	9	0,20	0,14	0,08	0,12	0,06	0,12	0,11	0,12	0,10	0,06	0,10
			X avg.	14,04	24,8	2,69	1,09	1,08	1,07	1,08	1,08	1,09	1,09	1,11	1,14	1,52
			S	0,040	2,348	0,084	0,044	0,028	0,054	0,021	0,048	0,037	0,038	0,030	0,022	0,040
			V	2,24	9,47	3,13	3,98	2,56	5,09	1,92	4,42	3,42	3,48	2,72	1,96	2,62
over 14,50 sec.		39	21	SR Correlation		0,689	0,809	0,835	0,869	0,932	0,945	0,954	0,919	0,957	0,860	0,611
		Variance	X min	14,58	18	2,64	1,12	1,10	1,10	1,12	1,11	1,10	1,14	1,15	1,15	1,54
			X max	17,9	30	3,20	1,40	1,38	1,44	1,42	1,42	1,46	1,48	1,49	1,87	2,16
			R	3,32	12	0,56	0,28	0,28	0,34	0,30	0,31	0,36	0,34	0,34	0,72	0,62
			X avg.	15,72	23	2,82	1,20	1,21	1,21	1,22	1,23	1,25	1,26	1,28	1,31	1,74
			S	0,858	3,801	0,112	0,064	0,070	0,073	0,072	0,084	0,091	0,089	0,095	0,127	0,150
			V	5,46	16,51	3,99	5,36	5,77	6,01	5,93	6,87	7,27	7,02	7,42	9,74	8,62

Note: The correlation data is presented in two colors (green stands for 95% statistical significance and orange stands for 99% statistical significance).

Figure 1 present intermediate times variance coefficient (V%). From there it is clearly visible the significant time drop after 5th hurdle – this fact is valid for youth, junior and men with lower levels. The hurdlers with higher level of qualification reveal different stricture of covering the competition distance. There we find more differences in the first half of the distance, and for the second one there are more similarities compared with the hurdlers with lower levels of sport qualification.

Figure 2 reveals the running time splits for clearing parts of the distance (clearing hurdle intermediates – average values) for all included in the study respondent groups. Also notable from the figure is the speed drop (revealed with the slower time) in the second part of the distance. We see some logical paths of all investigated age groups and levels of qualification. Also from here is visible the speed drop (presented in time value) at the end of the distance – after 7th-8th hurdle.

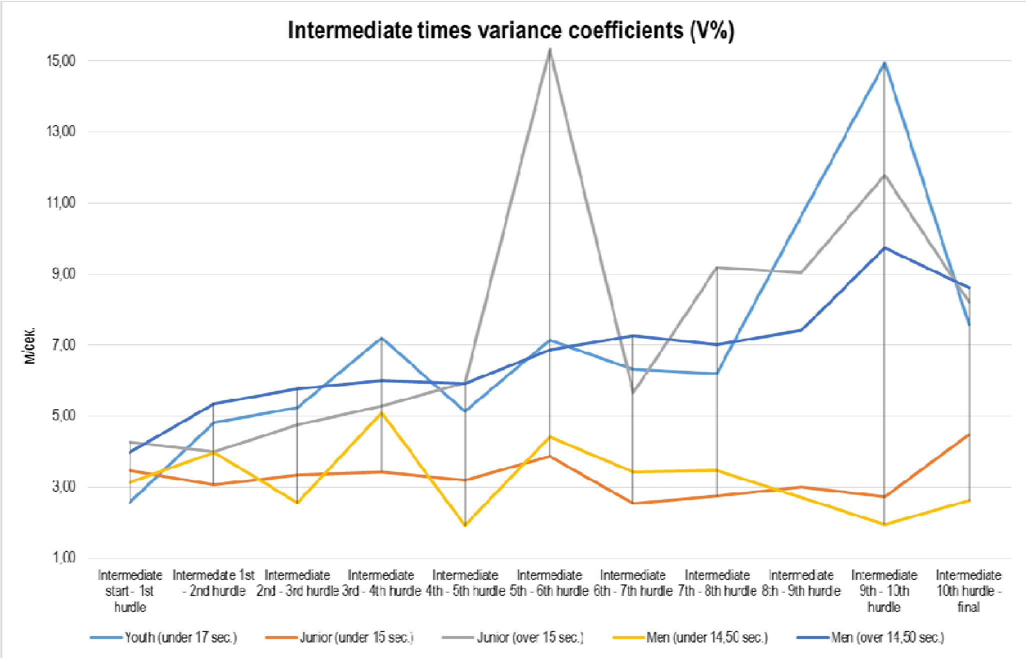

Figure 1.

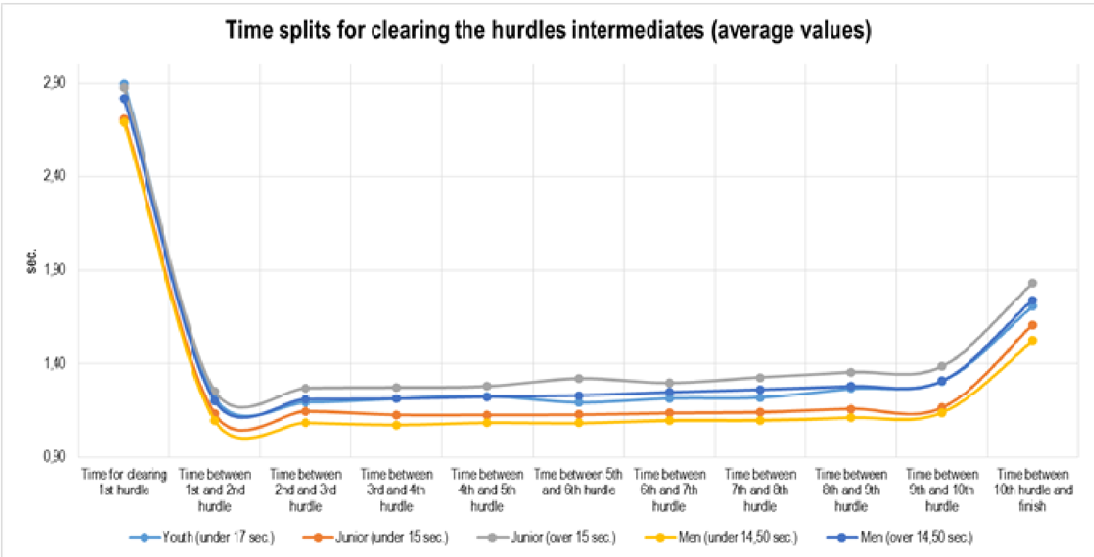

Figure 2.

The average sport result of the youth group is 15,58 sec. (avg. age 16,2 years). Best intermediate times for this age group vary between 1,09-1,12 sec. – measured between 1st and 5th hurdle. The average values for the first half of the distance ranges between 1,19-1,21 sec. The standard deviation (S) vary between 2,75-7,14 sec., but we find significant change at the end of the race – after 8th hurdle where the values of S are over 10. (Table 1, Figures 1 and 2)

The correlation between intermediate times and the final results is presented on Figure 3 (table 1). Here we must note that the higher level of interrelation means more stability in the sport results – in other words hurdlers clear the intermediate split with the same manner, if the correlation levels are low – it means that athletes run differently and get similar results. We find very high and functional correlation levels between 2nd and 8th hurdle (r>0,800) so we can conclude that hurdlers cover this distance in similar manner. But from the start to 1st hurdle and the distance after 8th hurdle reveal difference and individual character of running (most likely different time and from there running speed). (Table 1, Figures 3)

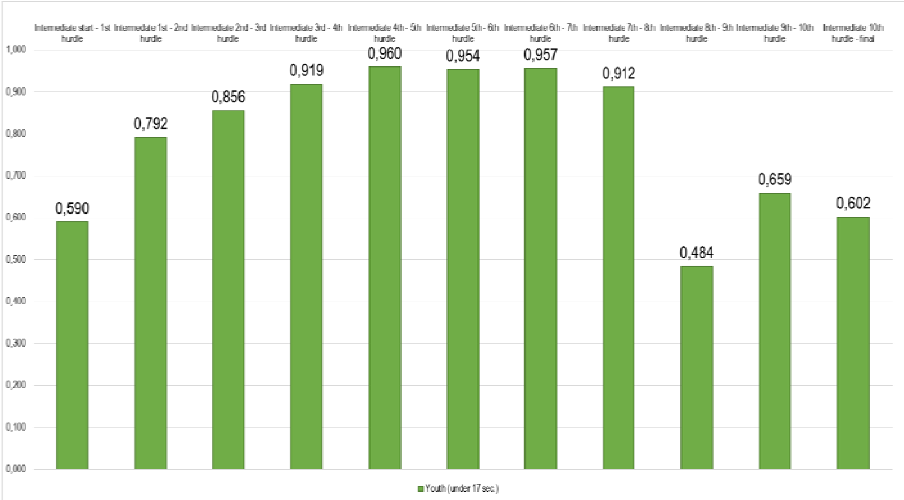

Figure 3. Correlation between sport result and running intermediate times for youth age group.

The junior group is divided to two parts – with results faster than 15 sec. (high level of qualification) and slower than 15 sec. (low level of qualification). In the first group the average sport results is 14,54 sec., compared to 16,43 sec. for the second group. The age average values are as follows: 18,6 years and 18 years. We find great differences in the average running intermediate times between the two groups. The first have average time for clearing 1st hurdle 0,18 sec. faster compared to the second group. This tendency is valid for all parts of the 110 meters distance – in fact the gap is widening at the second part of the distance. Also we find significantly lower standard deviation (S) values for the group of high qualification hurdler compared with lower level of qualification. Fastest average times for clearing intermediates for the first group are around 1,12-1,14 sec., and for the second group they vary between 1,25-1,28 sec. This also means lower level of running speed for the second group. (see Table 1, Figures 1 and 2)

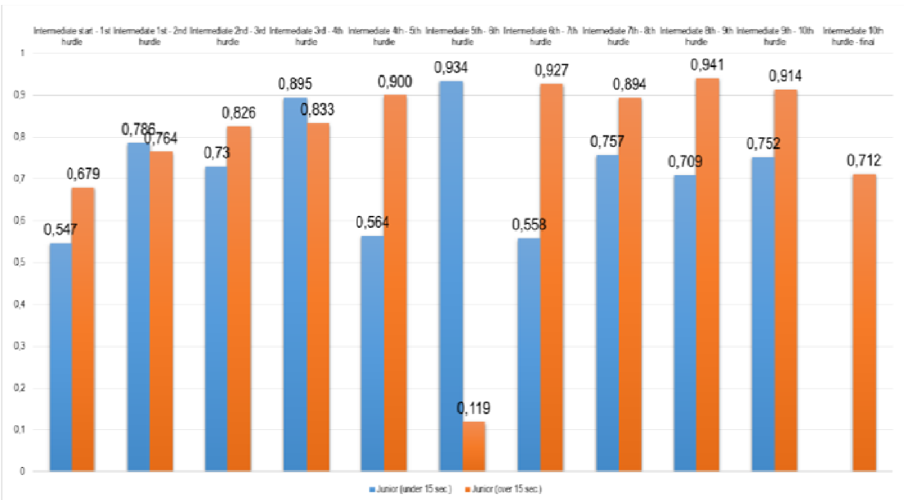

Figure 4. Correlation between sport result and running intermediate times for junior age group.

Figure 4 presents correlation levels between sport result and intermediate for junior age group – both levels of qualification. Correlation levels form the start to 3rd hurdle for the two groups are similar but from there we find significant differences. The second group have higher levels for almost all intermediates which speaks for similar way of running. For the first group we find similarities between 5th and 6th hurdke and from 7th to 10th hurdle. From the 10th hurdle to the finish line all athletes with high qualification run in a different way (different running speed levels). (Table 1)

The men groups is divided in two sub-groups based on their level of sport qualification – with results faster than 14,50 sec. and slower than 14,50 sec. The average value of the first group is 14,04 sec. (the fastest time is 13,64 sec.), and for the second groups is 15,72 sec. Age average value for the first group is 24,8 years and for the second – 23. Obviously the respondents from the second group are less qualified and younger. Here we find similar differences between qualified and less qualified athletes regarding intermediate times – for example best average intermediates vary between 1,07-1,09 sec. for the first group and 1,21-1,23 sec. for the second one. The same view is with the best intermediates. Standard deviations regarding the first group are smaller (S<6 sec.) compared with the second group (S>5 sec.). (see Table 1, Figure 1 and 2)

Figure 5 presents correlation between the sport result and intermediate times for both levels of qualification in the men age group. Here we find high (functional correlation levels – r>0,800) interrelations between 1st and 10th hurdle – a proof for similar running pattern for the less qualified group. The view for the hurdlers with higher level of correlation is a little different. From the start to the 1st hurdle they all run in the same pattern, but after that we find low correlation level between 1st and 2nd hurdle – a reason for this may be the dealing with 7 stride running rhythm to the first hurdle and the running transition to 3 stride running rhythm between the hurdles. After that the correlation levels are getting higher (r>0,700) to the 8th hurdle and from there we view individual way of dealing with the speed drop (special hurdle endurance).

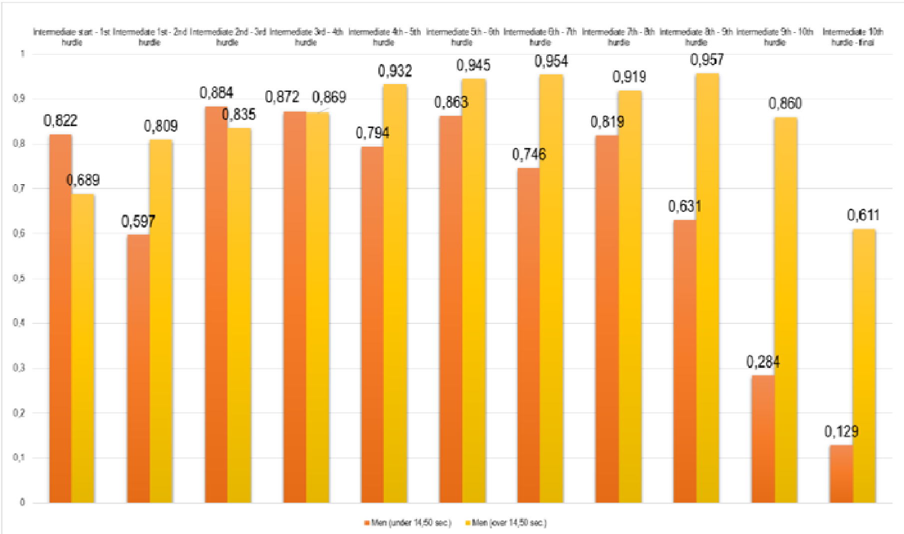

Figure 5. Correlation between sport result and running intermediate times for men age group.

Table 2 present the variance results of running splits. This information will be useful for sport specialist. They will be able to compare results and control athletes' performance. We must note that here we present fastest, slowest and average results. Here can clearly see the time differences between the qualified and less-qualified groups.

Table 2.

Running time splits for all age groups

results range	age group			Sport results (SR) - sec.	Time 1st hurdle	Time 2nd hurdle	Time 3rd hurdle	Time 4th hurdle	Time 5th hurdle	Time 6th hurdle	Time 7th hurdle	Time 8th hurdle	Time 9th hurdle	Time 10th hurdle
under 17 sec.	Youth	variance	X min	14,57	2,8	4,0	5,1	6,2	7,4	8,5	9,6	10,6	11,9	13,1
			X max	16,72	3,1	4,3	5,6	7,0	8,3	9,6	10,9	12,2	13,6	14,9
			X avg.	15,58	2,90	4,12	5,31	6,52	7,75	8,93	10,15	11,34	12,56	13,87
under 15 sec.	Junior	variance	X min	13,98	2,5	3,6	4,7	5,8	6,8	7,9	9,0	10,1	11,2	12,3
			X max	14,9	2,8	4,0	5,2	6,4	7,5	8,6	9,8	11,0	12,1	13,3
			X avg.	14,54	2,70	3,83	4,98	6,10	7,23	8,35	9,48	10,62	11,78	12,94
over 15 sec.		variance	X min	15,24	2,6	3,8	5,0	6,2	6,7	8,4	9,6	10,9	12,1	13,4
			X max	18,93	3,2	4,5	5,9	7,3	8,8	10,2	11,7	13,2	14,8	16,7
			X avg.	16,43	2,88	4,13	5,40	6,67	7,91	9,24	10,53	11,86	13,22	14,60
under 14,50 sec.	Men	variance	X min	13,64	2,6	3,7	4,7	5,8	6,8	7,8	8,9	10,0	11,1	12,2
			X max	14,47	2,8	4,0	5,1	6,2	7,3	8,4	9,5	10,6	11,8	12,9
			X avg.	14,04	2,69	3,78	4,86	5,93	7,01	8,09	9,18	10,28	11,39	12,52
over 14,50 sec.		variance	X min	14,6	2,6	3,8	5,0	6,1	7,2	8,3	9,4	10,6	11,8	13,0
			X max	17,9	3,2	4,6	6,0	7,4	8,8	10,3	11,7	13,1	14,6	16,1
			X avg.	15,72	2,82	4,02	5,23	6,44	7,66	8,89	10,14	11,40	12,68	13,98

CONCLUSION

The following study revealed in details 110 m hurdle running speed dynamics using intermediate times for three age groups and 5 different qualification levels (one for youth, two for juniors and two for men). The presented data is useful for sport practice for on field athletes' control.

From the speed analysis we can summarize the following:

- For achieving results faster than 14,50 sec. athletes must reach intermediates faster than 1,10 sec. for all race distance and best intermediates around 1,00-1,06 sec.
- For achieving high level results no matter the age group hurdles must show good levels of speed endurance presented by less speed drop at the second part of the distance.
- Results slower than 15,00 sec. are characterized by huge running speed drops and average intermediates around 1,25-1,40 sec.

Sport results correlation gave us some interesting results as follows:

- Running speed intermediates correlate significantly with sport result for almost all competition distance for slower results (>15,00 sec.) meaning that low qualification hurdlers have similar running pattern.
- High level results (<15,00 sec.) correlate only with first half of the competition distance (high levels) meaning that all of them run with similar pattern during the first part of the race and have individual style of running (speed levels) during the second part.

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MODELLING 110 M HURDLE STRIDE BASED ON SPORT RESULT FACTORS (YOUTH AGE GROUP)

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SUMMARY

The aim of the following study is to reveal the influence of the main complex factors on hurdle clearance technique and help modelling and control sport result. The aim is achieved using high speed video recording (120 fps) and free for using computer software. Also based on correlation analysis we selected certain parameters and from there regression model (incl. reverse regression models) were developed for control of those kinematic indexes. In the study were included 20 respondents in youth age group.

Keywords: 110 m hurdles, youth, modelling

INTRODUCTION

The discipline 110 m hurdle for youths (age U18) consists of clearing 10 barriers (height 91,4 cm) using specific technique – the hurdle stride. Hurdle stride is similar to running stride but have its differences. Distances between hurdles and hurdle height is constant so hurdlers must adapt to it for achieving high level results.

There are many studies researching hurdle technique but they are aimed only at clearing single hurdle (or two consecutive hurdles). One of the most detailed analysis of hurdle clearance technique is the one presented by M. Coh.

The main idea of the following study is based on complex factor having influence on sport result (based on M. Buchvarov theory based on Sportology as a specific science approach): start acceleration (from the start line to the 2nd or 3rd hurdle), running with maximum speed (between 3rd and 5th hurdle) and specific (hurdle) endurance (the significant speed drop after 8th hurdle).

METHODS

The aim of the following study is to reveal the influence of the main complex factors on hurdle clearance technique and help modelling and control sport result. This is done with the help of video analysis using high speed camera (Casio Exilim EX-ZR300 recording with 120 fps) and free (open source) software Kinovea 0.8.15. The camera is positioned perpendicularity next to the hurdles. We traced several angular, metric and time indexes (kinematic indexes) as well as three indexes calculated using mentioned above specialized software. All data was recorded during official competition on National (Bulgarian National Championships 2014 and 2015) and Balkan level (Balkan Championship 2014) using a set of kinematic indexes (in total 36 indexes were used, but at the end 26 proved to be useful after the statistical analysis) – see Table 1.

The following study included 20 youth hurdlers (in total 60 cases were investigated). The main idea of analyzing and modelling kinematics during official competitions is due to the fact that there hurdlers present their best results during race. Respondents average result is 15,56 sec. (best result is 14,16 sec. and slowest result is 18,54 sec.). Standard deviation of respondents sport result is 1,33 sec. with variance coefficient (V%) equal to 8,55.

Table 1

HURDLE STRIDE RESEARCH INDEXES

	№	signiture	index	measrured in	accuracy
HURDLE ATTACK (A)	1	A_Ti_1	Bracking phase contanct time (Take-off)	sec.	0,008
	2	A_ANG_1	Touchdown angle (bracking phase)	degrees	1
	3	A_ANG_3	Swing leg knee angle (during touchdown)	degrees	1
	4	A_ANG_4	Body incline during touchdown (brackin phase)	degrees	1
	5	A_LEN_1	Distance between body and touchdown point	cm	1
	6	A_ANG_6	Swing leg knee angle during vertical moment	degrees	1
	7	A_ANG_8	Take-off angle	degrees	1
	8	A_ANG_10	Attacking knee elevation angle	degrees	1
	9	A_ANG_11	Body incline during take-off	degrees	1
	10	A_LEN_2	Distance between body and contact point during take-off	cm	1
	11	A_Ti_3	Total contact time during hurdle attack	sec.	0,008
	12	A_LEN_3	Distance between trail leg contact point and hurdle	cm	1
FLIGHT PHASE (FL)	13	FL_ANG_14	Angle between hips when attack leg is fully extended during flight	degrees	1
	14	FL_LEN_4	Hurlde clearing minimum height	cm	1
	15	FL_Ti_4	Flight time duration	sec.	0,008
LANDING (L)	16	L_ANG_16	Body incline during touchdown after the hurdle	degrees	1
	17	L_ANG_17	Angle between hips during touchdown after the hurdlle	degrees	1
	18	L_LEN_6	Distance between landing contact point and hurdle	cm	1
	19	L_Ti_5	Landing break phase contact time	sec.	0,008
	20	L_ANG_18	Propulsion phase angle (for 1st running stride)	degrees	1
	21	L_ANG_20	Body incline durng propulsion phase for 1st running stride	degrees	1
	22	L_Ti_6	Contact time - propulsion phase during landing	sec.	0,008
	23	L_Ti_7	Total contact time during landing	sec.	0,008
SPEED INDEXES (SP)	24	V_1	Hurdle clearing speed	m/sec.	0,1
	25	V_2	Attacking leg speed before reaching the hurdle bar	m/sec.	0,1
	26	V_3	Attacking leg speed between the hurdle bar and touchdown	m/sec.	0,1

RESULTS AND DISCUSSION

Statistically significant correlation between the sport result and research indexes for clearing first hurdle by respondents are presented on Figure 1. From there we can note that in total 17 indexes measured in 1st hurdle correlation with the sport result (appear to be stable for all respondents). From them 5 are angular, 5 are measuring time duration, 4 are metric and 3 are computer measured speed indexes. The correlation between sport result and these indexes is a proof for stability of these indexes and means also that they can be measured and controlled for competitors of all levels of qualification.

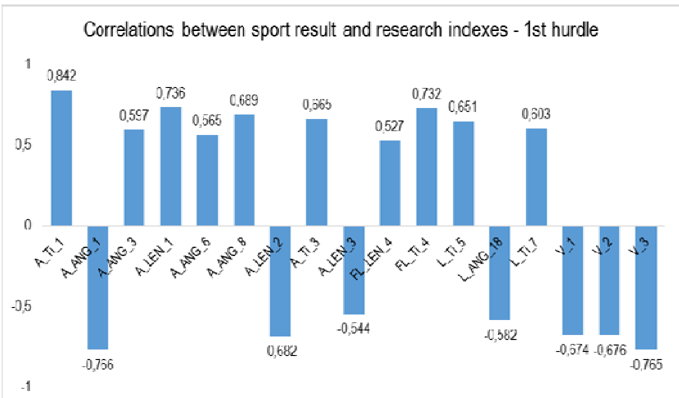

Figure 1.

The number of correlating indexes and sport result for the 3rd hurdle is smaller meaning that hurdlers have individual style of maximum running speed and from there only 12 indexes are valid for control and trace. From them 6 are presenting different period's time duration, 2 are presenting distance 2 are angular, and the last 2 are software measured speed values. (see Figure 2)

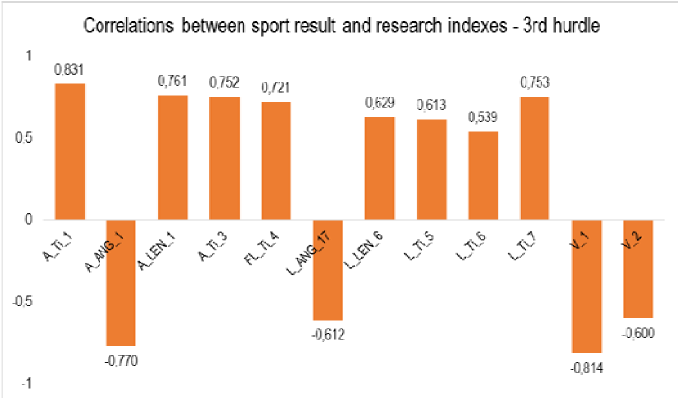

Figure 2.

Analyzing the correlation regarding 9th hurdle we can note the great number of indexes (in total 20 indexes) correlating with the sport result. This makes us conclude that specific for clearing 9th hurdle is fatigue (special hurdle endurance) accompanied by significant speed drop and from there we see stabilization of more indexes compared to 1st and 3rd hurdle. From the 20 parameters, 10 are angular, 6 are presenting time duration of different phases, 1 is presenting distance and here we add the last 3 speed indexes.

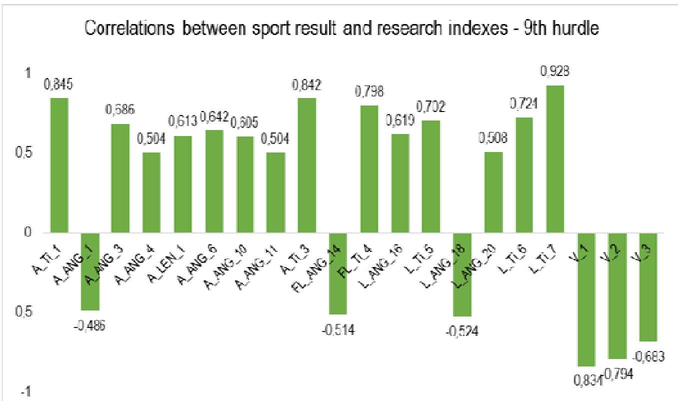

Figure 3.

In summary of the figures (from 1 to 3) representing correlation between studied parameters and sport result we can say that greatest number of correlation (and from there greater levels of stability) have angular and time parameters (total 17 correlations), followed by speed (8) and length indexes (7).

All statistically significant correlations (r) with average result (X avg.), variance coefficients (V%) and standard deviations (S) are presented in Table 1. Using this date we developed regression models (including reverse regression) for all indexes measured at 1st (see Table 2), 3rd (see Table 3) and 9th hurdle (see Table 4). Using these regression models we can control theoretically all indexes and predict sport result or the other way around – using the sport result to predict kinematic indexes values. All presented data is based on actual results and the calculations are not made using theoretical results.

Table 1

			1st hurdle				3rd hurdle				9th hurdle			
	№	index	r	V%	X avg.	S	r	V%	X avg.	S	r	V%	X avg.	S
HURDLE ATTACK (A)	1	A_Ti_1	0,842	24,53	15,56	1,33	0,831	20,29	0,078	0,016	0,845	20,9	0,077	0,016
	2	A_ANG_1	-0,766	8,44	61	5,15	-0,770	5,92	61	3,59	-0,486	5,82	60	3,49
	3	A_ANG_3	0,597	17,88	80	14,30					0,686	13,38	74	9,93
	4	A_ANG_4									0,504	4,47	82	3,69
	5	A_LEN_1	0,736	14,79	39,65	5,862	0,761	11,16	40,5	4,52	0,613	9,51	41,34	3,93
	6	A_ANG_6									0,642	21,67	48	10,30
	7	A_ANG_8	0,689	5,16	72	3,69								
	8	A_ANG_10									0,605	17,62	71	12,51
	9	A_ANG_11									0,504	7,56	72	5,450
	10	A_LEN_2	-0,682	15,51	41,41	6,423								
	11	A_Ti_3	0,665	11,14	0,14	0,016	0,752	10,22	0,15	0,154	0,842	13,24	0,15	0,019
	12	A_LEN_3	-0,544	12,00	185,47	22,263								
FLIGHT PHASE (FL)	13	FL_ANG_14									-0,514	12,09	109	13,15
	14	FL_LEN_4	0,527	6,51	14,12	6,518								
	15	FL_Ti_4	0,732	18,14	0,39	0,071	0,721	14,22	0,41	0,057	0,798	15,36	0,39	0,059
LANDING (L)	16	L_ANG_16									0,619	9,93	69	6,81
	17	L_ANG_17					-0,612	18,51	88	16,31				
	18	L_LEN_6					0,629	23,64	138,43	32,730				
	19	L_Ti_5					0,613	19,15	0,06	0,012	0,702	20,34	0,06	0,012
	20	L_ANG_18	-0,582	8,93	60	5,32					-0,524	7,59	59	4,49
	21	L_ANG_20									0,508	7,16	80	5,73
	22	L_Ti_6					0,539	14,38	0,06	0,009	0,724	16,25	0,07	0,011
	23	L_Ti_7	0,603	19,31	0,11	0,022	0,753	12,87	0,12	0,016	0,928	13,92	0,12	0,017
SPEED INDEXES (SP)	24	V_1	-0,674	10,09	7,23	0,729	-0,814	6,29	7,10	0,45	-0,834	8,18	7,27	0,59
	25	V_2	-0,676	11,22	13,12	1,472	-0,600	11,63	12,19	1,42	-0,794	13,30	12,62	1,68
	26	V_3	-0,765	10,80	6,60	0,712					-0,683	8,73	6,79	0,59

Table 2 Regression models of hurdle stride technique – 1st hurdle.

index	Regression model	R^2	Sy/x	Reverse regression model
A_Ti_1	y=62,857x+10,996	0,708	0,742	y=0,011x-0,103
A_ANG_1	y=27,638-0,1978x	0,586	0,884	y=107,22-2,9658x
A_ANG_3	y=0,056x+11,119	0,357	1,102	y=6,419x-19,904
A_LEN_1	y=0,167x+8,941	0,541	0,931	y=3,2417x-10,805
A_ANG_8	y=0,2484x-2,2204	0,4751	0,996	y=1,9123x+41,825
A_LEN_2	y=21,414-0,1413x	0,465	1,005	y=92,635-3,2912x
A_Ti_3	y=54,99x+7,6159	0,4427	1,026	y=0,0081x+0,0192
A_LEN_3	y=0,0325x+21,596	0,2961	1,153	y=327,15-9,1034x
FL_Ti_4	y=13,587x+10,197	0,5351	0,937	y=0,0394x-0,218
L_ANG_18	y=24,231-0,1456x	0,383	1,118	y=95,695-2,3238x
L_Ti_7	y=36,401x+11,407	0,3639	1,096	y=0,01x-0,0414
V_1	y=24,456-1,2298x	0,4547	1,015	y=12,986-0,3698x
V_2	y=23,579-0,611x	0,4567	1,013	y=24,755-0,7476
V_3	Y=24,994-1,429x	0,585	0,855	y=12,976-0,4097x

Table 3 Regression models of hurdle stride technique – 3rd hurdle.

index	Regression model	R^2	Sy/x	Reverse regression model
A_Ti_1	y=63,913x+11,046	0,6907	0,706	y=0,018x-0,0952
A_ANG_1	y=31,882-0,2615x	0,5926	0,81	y=96,914-2,2658x
A_LEN_1	y=0,2052x+7,7295	0,5784	0,824	y=2,8189x-4,7149
A_Ti_3	y=59,644x+7,0721	0,5649	0,837	y=0,0095x-0,0016
F_Ti_4	y=15,195x+9,8579	0,5199	0,879	y=0,0342x-0,142
L_ANG_17	y=20,071-0,0457x	0,3744	1,004	y=219,46-8,1866x
L_LEN_6	y=0,0234x+12,797	0,3954	0,987	y=16,877x-132,28
L_Ti_5	y=64,415x+12,138	0,3756	1,003	y=0,0058x-0,033
L_Ti_6	y=71,232x+11,466	0,291	1,069	y=0,0041x-0,0013
L_Ti_7	y=57,166x+8,9065	0,5668	0,835	y=0,0099x-0,0343
V_1	y=31,804-2,2194x	0,6618	0,738	y=11,886-0,2982
V_2	y=22,33-0,5158x	0,3598	1,015	y=23,384-0,6976x

Table 4 Regression models of hurdle stride technique – 9th hurdle.

index	Regression model	R^2	Sy/x	Reverse regression model
A_Ti_1	y=10,845+62,043x	0,715	0,64251	y=0,012x-0,103
A_ANG_1	y=25,487-0,165x	0,236	1,05135	y=82,234-1,435x
A_ANG_3	y=9,566+0,082x	0,471	0,87545	y=5,766x-15,844
A_ANG_4	y=2,307+0,161x	0,254	1,03893	y=57,875+1,575x
A_LEN_1	y=8,006+0,184x	0,376	0,95056	y=9,482+2,039x
A_ANG_6	y=12,125+0,074x	0,412	0,92265	y=5,598x-39,908
A_ANG_10	y=11,571+0,57x	0,366	0,95827	y=6,404x-29,055
A_ANG_11	y=7,744+0,109x	0,254	1,03881	y=35,707+2,327x
A_Ti_3	y=8,108+50,514x	0,710	0,64843	y=0,014x-0,071
FL_ANG_14	y=20,646-0,046x	0,264	1,03215	y=198,156-5,720x
FL_Ti_4	y=9,488+15,889x	0,636	0,72556	y=0,040x-0,240
L_ANG_16	y=8,258+0,108x	0,384	0,94451	y=12,638+3,569x
L_Ti_5	y=11,549+71,981x	0,492	0,85708	y=0,007x-0,050
L_ANG_18	y=23,790-0,138x	0,275	1,02445	y=90,244-1,991x
L_ANG_20	y=7,242+0,105x	0,258	1,03613	y=41,448+2,463x
L_Ti_6	y=10,361+79,989x	0,524	0,83032	y=0,007x-0,036
L_Ti_7	y=7,748+64,338x	0,861	0,44786	y=0,013x-0,087
V_1	y=27,674-1,657x	0,695	0,66415	y=13,824-0,419x
V_2	y=22,684-0,560x	0,631	0,73062	y=30,238-1,128x
V_3	y=24,858-1,360x	0,466	0,87926	y=12,145-0,343x

CONCLUSION

The following study reveals hurdle stride kinematic structure changes under the influence of sport result main factors in the age group youths. Through the establishment of stable factors (for certain part of the race distance) valid for all respondents we developed a system for control based on regression models – presented in Tables 2, 3 and 4. Also we found a number of kinematic parameters that can be applied to athletes in this age group and level of qualification.

Also we recommend development of tables representing individual hurdling technique models for better control and understanding of each athlete individual features based on their anthropometry and physical abilities.

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OPTIMIZING SHOT PUT THROWERS STRENGTH DEVELOPMENT

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SUMMARY

The aim of the following study is to improve shot put thrower training process management by strength development optimization. Shot put throwers (10 of the best Bulgarian shot put throwers) strength abilities are investigated for long period of their sport career when achieving their personal bests. In total six indexes were traced (5 presenting strength abilities and the last one is the sport result). Also several ways of strength control and management during training process were offered, developed based on actual sport results of elite shot put throwers – a prerequisite for immediate application in sport practice.

Keywords: shot put, strength training, optimization

INTRODUCTION

Shot put is a discipline in which strength abilities dominate. Sport specialists identify shot put throwers as one of the strongest (with greatest strength abilities) athletes among all track and field athletes.

A number of training exercises are specialized and aimed at strength development in sports practice. Generally, information about them refers to maximum strength abilities of elite shot put throwers closely related to their best sport result. We found insufficient knowledge regarding shot put throwers strength abilities at different sport qualification levels (different levels of sport and technical development) – information about the way of achieving results of elite international levels.

In our study we consider strength development of the best shot put throwers in Bulgarian athletics history. Thus we want to present their experience and help sport specialists and coaches who dedicate their efforts to develop the discipline.

METHODS

Our study is aimed at improvement of shot put throwers training process management by athletes' strength development optimization. In the following study are included the best Bulgarian shot put throwers of all times. We investigate their strength abilities and we are focused on indexes presenting the level of strength abilities of respondents. All respondents included in our study are presented in Table 1.

The strength abilities study was made based on physical abilities of the best 10 shot put throwers in Bulgaria for all times. (see Table 2) with personal best from 18,52 m to the impressive 21,09 m. We will clarify that the study includes data presenting respondents strength abilities for multiannual period of time – the period of their sport and technical evolution and years of personal best achievement. For example, in G. Todorov were examined physical abilities regarding the following sport results: 17,69 m, 18,34 m, 19,74 m, 19,99 m, 20,09 m, 20,48 m, 20,69 m and 21,01 m (ex-national record). Physical abilities of the following athlete from years in which he did not achieve PB are not included. The total number if analyzed cases is 45.

This way in a higher level is presented the quality aspect of successful training process – mix of technical and physical training processes.

For having a better insight into the nature of shot put throwers strength potential we traced changes in 6 indexes (see Table 2)

Table 1 Respondents include in the study.

№	name	nationality	result (m)
1	Georgi Ivanov	Bulgarian	21,09
2	Georgi Todorov		21,01
3	Ventzislav Hristov		20,83
4	Vulcho Stoev		20,72
5	Nikola Hristov		20,44
6	Nikolay Gemedjiev		20,20
7	Radoslav Despotov		20,13
8	Galin Kostadinov		20,10
9	Mihail Kyoshev		19,90
10	Rosen Karamfilov		18,52

Table 2 Indexes presenting shot put throwers strength abilities.

index	name	measured in:	accuracy:
SR (Y)	Sport result	m	0,01
X1	Squat with barbell on shoulders	kg	1
X2	Barbell bench press	kg	1
X3	Barbell overhead push press	kg	1
X4	Barbell snatch	kg	1
X5	Barbell push from a rack	kg	1

RESULTS AND DISCUSSION

Studied indexes variance. Table 3 presents the results from the variance analysis.

We observe a highly qualified sample (respondents) regarding the sports result (Y) – respondents' average sport results is 19,44 m. Also we are presenting a wide range of sport qualification levels – ranges is 4, 81 m (from 16,28 m to 21,09 m). The last value covers the period from entering sport mastery until reaching world elite levels. This is a good prerequisite for useful findings for sport practice and theory.

We must emphasize that in terms of strength abilities Bulgaria throwers possess enviable potential – evidence for this are all indexes presenting the strength potential.

Overall, the data sample is highly homogeneous with a normal Gaussian cases distribution. The latter is confirmed by statistical indexes presented in the table below.

Table 4 presents research data correlation matrix. The same allows us to define examine indexes as such of great importance for the sport results (r>0,64). It also allows us to apply regression analysis for modelling strength training of shot put throwers.

The high correlation levels are easily explainable – research indexes are integral part of shot put throwers physical preparation and are proven as reliable over the years.

Also logical is the high level of interrelations among indexes – in one or other degree they are similar by form and content, as well as a rhythmic structure. Using the way of positive transmission the development of each one of studied indexes has a positive impact on the development of all others.

Table 3 Research data variance analysis.

	Y	*X1*	*X2*	*X3*	*X4*	*X5*
X avg	19,44	249,56	202,65	128,24	155,15	170
Mx	0,23	5,97	5,82	3,04	3,23	2,83
Me	19,95	245	200	132,5	157,5	170
Mo	20,3	260	200	135	165	170
Sx	1,34	34,82	33,96	17,7	18,85	16,51
Sx2	1,79	1212,7	1153,4	313,46	355,28	272,73
Ex	-0,01	-0,71	-0,17	-0,88	-0,09	-0,12
As	-1,02	0,23	0,53	0,01	0,15	-0,05
R	4,81	130	130	65	80	65
Xmin	16,28	200	150	100	125	135
Xmax	21,09	330	280	165	205	200
Vx%	6,89	11,95	11,76	11,81	12,15	9,71

Table 4 Correlation matrix.

	Y	**X1**	**X2**	**X3**	**X4**	**X5**
Y	1					
X1	0,73	1				
X2	0,7	0,81	1			
X3	0,83	0,85	0,73	1		
X4	0,85	0,87	0,8	0,95	1	
X5	0,79	0,52	0,71	0,59	0,66	1

Physical abilities modelling is made with the help of regression analysis. Table 5 presents normal and reverse regression models. Table 6 presents multiple regression models. Also in the tables is presented information regarding standard deviation (S) and correlation coefficients (r).

Table 5 Regression models.

Normal regression models		r y/x	**Reverse regression models**	
Y = a + b.X	S y/x		X = a + b.Y	S x/y
Y = 12,454 + 0,028.X1	0,93	0,73	X1 = -118,206 + 18,917.Y	24,3
Y = 13,841 - 0,028.X2	0,97	0,7	X2 = -142,601 + 17,758.Y	24,6
Y = 11,394 + 0,063.X3	0,76	0,83	X3 = -84,827 + 10,959.Y	10,1
Y = 10,051 + 0,061.X4	0,71	0,85	X4 = -77,774 + 11,981.Y	10,0
Y = 8,612 + 0,064.X5	0,84	0,79	X5 = -18,170 + 9,679.Y	10,4

Table 6 Multiple regression model.

Multiple regression model	*r y/xx*	*S y/xx*
Y = 6,996 + 0,004.X1 - 0,007.X2 + 0,027.X3 + 0,017.X4 + 0,04.X5	0,913	0,592

With the help of the information above we make easier to control and plan the sport training process in tight relation with the physical development of the shot put thrower in operative and perspective aspect.

Table 7 (from "a" to "e") offers opportunity for qualitative assessment of shot put throwers physical capabilities developed using regression method. We use difference between theoretical calculations for the relevant index and the empirical (real) case value. Estimates are as follows: excellent use of physical abilities (5), very good use of physical abilities (4), good use of physical abilities (3), satisfactory use of physical abilities (2) and unsatisfactory use of physical abilities (1).

Comparing capabilities of each shot putter with the proposed evaluation tables makes control between two main components of training process (technical and physical preparation) easier and also we can identify and apply corrective measures.

Table 7a Qualitative assessment of shot put throwers squat with barbell on shoulders (X1) result.

Regression model Y = 12,454 + 0,028 . X1			*S y/x*	*r y/x*
evaluation	Yt - Ye		**Verbal expression of the evaluation**	
5	over	48,0 cm	excellent use of physical abilities	
4	from	24,0 cm	very good use of physical abilities	
	to	48,0 см		
3	from	-24,0 cm	good use of physical abilities	
	to	24,0 cm		
2	from	-48,0 cm	satisfactory use of physical abilities	
	to	-24,0 cm		
1	above	-48,0 cm	unsatisfactory use of physical abilities	

Table 7b Qualitative assessment of shot put throwers Barbell bench press (X2) result.

Regression model Y=13.841+0,028.X2			*S y/x*	*r y/x*
evaluation	Yt - Ye		**Verbal expression of the evaluation**	
5	over	49 cm	excellent use of physical abilities	
4	from	24,5 cm	very good use of physical abilities	
	to	49,0 cm		
3	from	-24,5 cm	good use of physical abilities	
	to	24,5 cm		
2	from	-49,0 cm	satisfactory use of physical abilities	
	to	-24,5 cm		
1	below	-49,0 cm	unsatisfactory use of physical abilities	

Table 7c Qualitative assessment of shot put throwers Barbell overhead push press (X3) result.

Regression model Y=11,394+0,063.X3			*S y/x*	*r y/x*
evaluation	Yt – Ye		**Verbal expression of the evaluation**	
5	over	20,0 cm	excellent use of physical abilities	
4	from	10,0 cm	very good use of physical abilities	
	to	20,0 cm		
3	from	-10,0 cm	good use of physical abilities	
	to	10,0 cm		
2	from	-20	satisfactory use of physical abilities	
	to	-10,0 cm		
1	below	-20,0 cm	unsatisfactory use of physical abilities	

Table 7d Qualitative assessment of shot put throwers Barbell snatch (X4) result.

Regression model Y=10,051+0,061.X4			*S y/x*	*r y/x*
evaluation	Yt – Ye		**Verbal expression of the evaluation**	
5	over	20,0 cm	excellent use of physical abilities	
4	from	10,0 cm	very good use of physical abilities	
	to	20,0 cm		
3	from	-10,0 cm	good use of physical abilities	
	to	10,0 cm		
2	from	-20,0 cm	satisfactory use of physical abilities	
	to	-10,0 cm		
1	below	-20,0 cm	unsatisfactory use of physical abilities	

Table 7e Qualitative assessment of shot put throwers Barbell push from a rack (X5) result.

Regression model Y=8,612+0,064.X5			Sy/x	ry/x
evaluation	Yt – Ye		**Verbal expression of the evaluation**	
5	over	20,8 cm	excellent use of physical abilities	
4	from	10,4 cm	very good use of physical abilities	
	to	20,8 cm		
3	from	-10,4 cm	good use of physical abilities	
	to	10,4 cm		
2	from	-20,8 cm	satisfactory use of physical abilities	
	to	-10,4 cm		
1	below	-20,8 cm	unsatisfactory use of physical abilities	

In Table 8 we present opportunity for qualitative assessment of shot put throwers strength abilities based on the sigmal method of assessment. It presents the level of development of corresponding index.

Table 8 Evaluation based on the sigmal method.

evaluation		Y	X1	X2	X3	X4	X5
excellent	over	22,12	319,21	270,57	163,64	192,84	203,03
very good	from	20,78	284,38	236,61	145,94	174	186,51
	to	22,12	319,21	270,57	163,64	192,84	203,03
good	from	18,1	214,74	168,69	110,53	136,3	153,49
	to	20,78	284,38	236,61	145,94	174	186,51
satisfactory	from	16,76	179,91	134,72	92,83	117,45	136,97
	to	18,1	214,74	168,69	110,53	136,3	153,49
unsatisfactory	under	16,76	179,91	134,72	92,83	117,45	136,97

For direct application of research results in sport practice we offer standards for individual strength development (see Table 9) presenting optimal levels of strength abilities according sport and technical abilities. This will help physical training optimization and harmonize strength development in line with the overall shot-putter development.

Table 9 Standards for individual strength development of shot put throwers in qualification aspect.

Y (m)	X1 (kg)	X2 (kg)	X3 (kg)	X4 (kg)	X5 (kg)
18	220	175	110	140	155
19	240	195	120	150	165
20	260	215	130	160	175
21	280	230	140	170	185
22	300	245	150	180	195
23	320	260	160	190	205

CONCLUSION

The study of shot put throwers strength potential allows us to explore quantitative-qualitative aspects of amendments in the researched indexes. With the improvement of the sport result from 18 to 23 meters we found significant changes in the strength potential as follows:

- Squat with barbell on shoulders – from 220 to 320 kg;
- Barbell bench press – from 175 to 260 kg;
- Barbell overhead push press – from 110 to 160 kg;
- Barbell snatch – from 140 to 155 kg;
- Barbell push from a rack – from 155 to 205 kg.

For improvement of training process control we need:

1. Development of individual models in qualification plan of physical development of athletes reached the world elite level.

2. Expanding the set of indexes for study and control of the physical potential, especially those reflecting the speed-strength abilities and special physical development of athletes.

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THE EFFECTS OF PLYOMETRIC TRAINING ON THE MOTOR SKILLS OF FEMALE BASKETBALL PLAYERS (Review)

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SUMMARY

Women's basketball on its way of development has faced some obstacles that were reflected in the isolation of physical education for female students (the problem of coeducation) and conservative rules of good behavior that did not allow girls to appear in shorts in front of the opposite sex. This led to the fact that women's basketball was developing much more slowly than men's. It was only in 1938 that female and male basketball was equated. Basketball consists of a number of explosive movements, such as, for example, short sprints, fast stops and accelerations, changes of direction, different jumps, throws and passing the ball. Plyometrics refers to the exercises that are designed to improve the ability of the muscles by using jumps and they are composed of natural movements. The aim of this study is to analyze the research in which the effects of plyometric training on the motor skills of female basketball players were studied. The research included 14 studies that were published in the period from 2001 to 2015. For collection, classification and analysis of the targeted research, descriptive methods and theoretical analysis were used and the studies that have been reached were searched on Google, Google Scholar, PubMed and Kobson. The analyzed results showed that plyometric training could lead to significant improvements in the height of vertical jump, agility, speed, flexibility and the situational-motor abilities of female basketball players, that the combination of plyometric training and weight training or dynamic stretching training could lead to significant improvements in the height of vertical jump and agility of female basketball players, that different types of plyometric training could have different effects on the motor skills of female basketball players.

Keywords: plyometrics, women's basketball, effects, motor skills

INTRODUCTION

It is known that basketball is designed and constructed so that it is played by men, because of the lack of interesting activities in physical education classes in the gym. Women's basketball, which was created from the same purposes, on its way encountered the obstacles that were reflected in the isolation of physical education for female students (the problem of coeducation) and conservative rules of good behavior that did not allow girls to appear in shorts in front of the opposite sex. This led to the fact that women's basketball was developing much more slowly than men's, so the rules changed and they were different from the rules in men's basketball where physical education teachers had to perform various modifications. It was only in 1938 that women's basketball was equated with men's basketball in the United States by being finally defeated by the idea that all players should have the same rights in attack and in defense. In 1922, the first organized women's team performance was organized at the international tournament in Monte Carlo (Jovanović, 1999). Basketball consists of many explosive movements such as, for example, short sprints, fast stops and accelerations, changes of direction, different jumps, throws and passing the ball (Erčulj, Dežman, & Vučković, 2004). Plyometrics is a popular method that is widespread among athletes with the aim of developing the ability to counteract the force of gravity (Jamurtas at al., 2000). When the coaches and athletes discovered that it is possible to improve performance with plyometrics, they started including it in their entire training program so that plyometrics has become an important factor in the planning of athletic development (Radcliffe & Farentinos, 2003). Plyometrics refers to the exercises that are designed to improve the ability of muscles by using jumps and they are composed of natural movements (de Villarreal, Kellis, Kraemer & Izquierdo, 2009). For a long time, the primary means of training to improve the vertical jump was lifting heavy loads from a deep squat. However, Verkoshanski claimed that while on the one hand, the lifting of heavy loads significantly improves the ability to manifest maximum force, at the same time, on the other hand, it reduces the speed of its development and often the speed of the transition from the eccentric to concentric muscle operation (Nedeljković, 2004). The emergence of plyometric training method binds specifically to the work of Verkoshanski from the second half of the 60s in the last century. In the West, people often talked about the "secret Russian training" ', which helped Soviet athletes to achieve a victory in international competitions (Mihajlović, Đinić & Petrović, 2010). The coaches of other athletes, by translating Verkhoshanski's work in which an exercise of jump in depth (depth jump) was described, solved the mystery. Then they started performing their own experiments to make this method of training more efficient (Nedeljković, 2004). The term plyometrics was created by the Europeans and was recognized as a Russian training method that uses an overload, and whose main purpose is the development of greater reactive force (Čanaki & Birkić, 2009). It derived from the Latin word '' *plio* '' which means more and “*metrios*'' which means measuring (Mihajlović, Đinić & Petrović, 2010). The elementary means of plyometric methods are vertical, horizontal and depth jumps (engl.drop jumps or in-depth jumps) (Branković, Stojiljković, Milenković & Stanojević, 2008). Plyometric training increases abilities such as jumping, starting acceleration, sprinting and the movements in which a change of direction (agility) happens. (Vrcić, 2009). The effects of plyometric training may differ depending on the different characteristics of subjects such as: training, gender, age, sports activity as well as knowledge of plyometric training (de Villarreal, Kellis, Kraemer & Izquierdo, 2009).

The aim of the research

The aim of this research is to analyze the research in which the effects of plyometric training on the motor skills of female basketball players were studied from 2001 to 2015.

METHOD OF THE RESEARCH

For collection, classification and analysis of the targeted research, the descriptive methods and theoretical analysis were used and the studies that have been reached were searched on Google, Google Scholar, PubMed and Kobson. The additional literature in the form of textbooks was used. The search was limited to the works that were published during the period from 2001 to 2015 and works in which the participants were women. The analyzed scientific studies were published in journals that have a significant impact factor. The key words used during the search were: ***plyometric training, women*** and ***basketball***. References from all the works were examined in order to reach more studies that had dealt with this topic. The accepted studies are those which have examined the effects of plyometric training on the motor skills of female basketball players.

THEORETICAL CONSIDERATION OF THE PROBLEM

Each work is illustrated by the following parameters: **the respondents' sample** (the total number of respondents, age and sex) and **the experimental treatment** (duration of the experiment, number of groups in the course of the study, the parameters that were measured, note, the program results and the differences between groups at the end of the experiment). In 11 out of 13 researches, the respondents were women, while in two studies there were both male and female respondents (Bavli, 2012; Ramachandran & Pradhan, 2014). The number of respondents in the research quite varied from study to study. The smallest number of respondents was in the work of Urtado, Leite, Gimenes & Assumpção (2012) and McCormick et al. (2015) and there were 14 respondents, and the largest number was in the research of Bavli (2012) and there were 91 participants. The experimental treatment lasted the least in the research of Ramachandran & Pradhan (2014) and it lasted for **two** weeks. The experimental treatment had the longest duration in the researches of Chang, Hsu, Chen & Lin (2005) and Bavli (2012) and it was **12** weeks. In addition, in 6 studies it lasted for **eight** weeks (Adibpour, Bakht & Behpour, 2012; Urtado, Leite, Gimenes & Assumpção, 2012; Komal & Singh 2013a; Komal & Singh, 2013b; Chidambara, 2014; Benis, Rossi, Russo & La Torre, 2015). In three studies, it lasted for **six** weeks (Chaudhary & Jhajharia, 2010; Attene et al., 2014; McCormick et al., 2015). In the study of Khazai & Hematfar (2015) it lasted for **four** weeks and in the research of Dadwal (2013) for **ten** weeks. In most of these studies, the program involved exercising 3 times a week. The youngest sample of respondents was in the study of Khazai & Hematfar (2015) and ranged from 12 to 13 years old, and the oldest sample of respondents was in the research of Chidambara (2014) and Dadwal (2013) and ranged from 19 to 25 years old.

References	sample of respondents			Experimental treatment					
	N	Age	sex	duration	Nb. of gr.	measured parameters	note	results	differences between groups
Chang, Hsu, Chen & Lin (2005)	16	16.53 ± 0.77	F	12 weeks (3x a week)	3P 1K	squat jump (SJ), counter-movement jump (CMJ) and Continuous Jump (CJ)	3P groups depending on whether in the plyometric training a bench of 30, 40 or 50cm is used for jumps	in P and K groups, a significant improvement on tests CMJ and CJ, there is no progress on test SJ	a group that used jumps from the bench of 50cm achieved significantly better progress than all other groups
Chaudhary & Jhajharia (2010)	20	18-22	F	6 weeks	1P 1K	vertical jump, 20m sprint, running speed, flexibility, agility	P group did not improve 20m sprint	P group significantly improved vertical jump, running speed, agility and flexibility	K group has not made significant progress
Adibpour, Bakht & Behpour (2012)	16	20.38± 3.7	F	8 weeks (3x a week)	1Pт 1K	vertical jump height	/	significant progress of Pt group in the height of vertical jump	Pt group achieved significantly better progress than group K
Urtado, Leite, Gimenes & Assumpção (2012)	14	13,28 ± 0,63	F	8 weeks (3x a week)	1P	fatigue index (anaerobic endurance)	/	significant reduction in the index of fatigue (2%)	/
Bavli (2012)	91	15-17	M F	12 weeks (3x a week)	1P 1K 1Pv	maximal leg strength, sprint of 30m, the height of vertical jump and flexibility	flexibility - Test Sit and Reach, peak leg power 1RM - leg press	a significant improvement in all measured parameters for P and Pv groups, there is no progress in K group	between P and Pv no significant difference / P and Pv significantly greater progress than K
Komal & Singh (2013)a	30	16-19	F	8 weeks	1P 1K	situational-motor skills (SMS)	for assessing SMS Johnson Basketball Ability Test was used	P group has made progress in 2 of 3 Johnson Basketball Ability Tests	K group has not made significant progress
Komal & Singh (2013)b	45	16-18	F	8 weeks	1P 1K 1O	flexibility, vertical jump height, speed, agility and endurance	/	O significantly greater improvement in flexibility than P and K, P and O significantly greater progress than K in the height of vertical jump and agility	P significantly greater progress than O and K in endurance and speed
Dadwal (2013)	40	18-25	F	10 weeks (3x a week/ 40-50min)	1P 1K	speed, agility, endurance	Sprint of 50m, 4x10m shuttle run, 12 min run-walk test	a significant improvement in agility and speed in P group, no significant improvement in endurance	P significantly better results than K in speed and agility, there is no difference in endurance
Ramachandran & Pradhan (2014)	30	20.4 ± 1.73	M F	2 weeks (3x a week)	1 DP	vertical jump height and agility	10min-stretching, 30min-plyometrics , 10min-stretching	significant improvement in agility and vertical jump	/
Attene at al. (2014)	36	14,9 ± 0,9	F	6 weeks	1P 1K	vertical jump height	K group had training of basketball technique	P and K group significantly increased the height of vertical jump	P group had significantly greater improvement compared to C group (15.4% vs. 7.5%)
Chidambara (2014)	20	19-25	F	8 weeks (3x a week)	1P 1K	situational-motor skills (SMS)	for the estimation of SMS Johnson Basketball Ability Test was used	P group made significant progress on all tests of SMS	P group statistically significantly greater progress than K group on all tests
Khazai &Hematfar (2015)	16	11-12	F	4 weeks(3x a week/ 60min)	1K 1P	vertical jump height	/	a significant improvement in the height of vertical jump	/

Table 1 – sample of respondents (N-total number, Age-age of respondents and Sex-sex of respondents) and the experimental treatment (duration of the experiment, Nb.of gr. - number of groups, measured parameters, note, results of the program, differences between the groups at the end of the experiment)

McCormick at al. (2015)	14	High School	F	6 weeks	1Psr 1Pfr	explosive power (4 tests) and agility (2 tests)	long jump, high jump,*lateral hop test* (left), *lateral hop test* (right), *lateral shuffle test* (left) and *lateral shuffle test* (right).	significant progress of Psr and Pfr group on all tests, in three of the six tests there is a significant difference between Psr and Pfr	Psr significantly better results on the test of high jump than Pfr, Pfr significantly better results on the tests of lateral hop (left) and lateral shuffle (left) than Psr
Benis, Rossi, Russo & La Torre (2015)	24	15.9 ± 0.8	F	8 weeks	1K 1P	the height of vertical jump, 20m sprint	/	P a significant improvement in the height of vertical jump, there is no progress in 20m sprint	no progress in K in the measured parameters

Legend: P-group that was subjected to plyometric program; **K**-control group; **Pv**-group that was subjected to the aquatic plyometric program; **Pt**-group that was subjected to combined plyometric training and weight training; **Psr**-group that performed plyometric jumps in the sagittal plane; **Pfr**- group that performed plyometric jumps in the frontal plane; **O**-group that was subjected to training with loads; **DP**- group that was subjected to a combination of dynamic stretching and plyometric exercises

RESULTS

In **seven** of the 14 studies, there were two groups. One group was the control group in which female basketball players were subjected only to normal daily activities, and the other group was the plyometric group where female basketball players were subjected to plyometric training for a specific period (Chaudhary & Jhajharia, 2010; Komal & Singh, 2013a; Dadwal, 2013 ; Attene et al., 2014; Chidambara, 2014; Khazai & Hematfar, 2015; Benis, Rossi, Russo & La Torre, 2015). In two studies there was only one group (Urtado, Leite, Gimenes & Assumpção, 2012; Ramachandran & Pradhan, 2014). In the studies of Adibpour, Bakht & Behpour (2012) and Ramachandran & Pradhan (2014), the authors investigated the influence of a combination of plyometric training and weight training, actually dynamic stretching on the motor skills of female basketball players. In **three** studies the authors compared the effects of different ways of plyometric training on the motor skills of female basketball players (Chang Hsu, Chen & Lin, 2005; Bavli, 2012; McCormick et al., 2015). In the study of Komal & Singh (2013)b the authors, in addition to the research on the effects of plyometric training on motor skills of female basketball players, compared the effect of plyometric training with the effect of weight training on the motor skills of female basketball players.

Most of the research investigated the effect of plyometric training on:

- **vertical jump height** (explosive force) – **10** studies (Chang Hsu, Chen & Lin, 2005; Chaudhary & Jhajharia, 2010; Adibpour, Bakht & Behpour, 2012; Bavli, 2012; Komal & Singh, 2013b; Ramachandran & Pradhan, 2014 ; Attene et al., 2014; McCormick et al., 2015; Khazai & Hematfar, 2015; Benis, Rossi, Russo & La Torre, 2015)
- **agility - 5** studies (Chaudhary & Jhajharia, 2010; Komal & Singh, 2013b; Dadwal, 2013; Ramachandran & Pradhan, 2014; McCormick et al., 2015)
- **speed - 4** studies (Chaudhary & Jhajharia, 2010; Bavli, 2012; Komal & Singh, 2013b; Dadwal, 2013)
- **flexibility- 3** studies (Chaudhary & Jhajharia, 2010; Bavli, 2012; Komal & Singh, 2013b)
- **durability -** 3 studies (Urtado, Leite, Gimenes & Assumpção, 2012; Komal & Singh, 2013b; Dadwal, 2013)
- **situational-motor skills- 2** studies (Komal & Singh, 2013a; Chidambara, 2014).

DISCUSSION

The effect of plyometric training on the motor skills of female basketball players

Success in basketball is largely dependent on how high an athlete can jump (Bobbert, 1990; Nedeljković, 2004). Some authors even claim that a basketball player in the whole match (40 minutes) perform up to 100 different jumps (Manojlović & Erčulj, 2013). The analysis of the presented research in Table No. 1 shows that in all of 10 analyzed studies that have examined the impact of plyometric training on the height of vertical jump of female basketball players, a positive effect was determined. Chang Hsu, Chen & Lin (2005) found that plyometric training for a period of 12 weeks (3x per week) leads to a significant improvement in the results of female basketball players on the tests Counter-Movement Jump (CMJ) and Continuous Jump (CJ), but it does not lead to a significant progress on the test Squat

Jump (SJ). There was no progress on the test Squat Jump (SJ) because basically plyometric training model has a cycle shortening-stretching or Stretch-Shortening Cycle-SSC. When the muscle is stimulated by a certain force (load), its reaction occurs. This reaction is a deflection in its dimensions, which is called elongation. Such deformation causes the accumulation of elastic strain energy, whose greatest part is stored in the muscle tendons. This creates greater muscular tension that will cause greater muscle strength (Kukrić, Petrović, Dobraš & Guzina, 2010). The period between the end of the eccentric and the beginning of the concentric contraction, is characterized by a short and strong isometric contraction and is called time of the merger. During concentric contraction, in order to use all the positive effects of the previous eccentric contraction, time of the merger must be short enough. Previously it was thought to be a period of about 0.15s, however, some later studies have produced values of 0.25s and 0.37s (Nedeljković, 2004). In Squat Jump (SJ) there is stretching of the muscles before performing the jump, but time of the merger is quite long so during this jump not all the positive effects of the previous eccentric contraction are used. Adibpour, Bakht & Behpour (2012) found that a combination of plyometric training and training with weights for a period of 8 weeks (3x per week) leads to a significant increase in the height of vertical jump of female basketball players. Benis, Rossi, Russo & La Torre (2015), Komal & Singh (2013)b found that plyometric training for 8 weeks, Bavli (2012) that plyometric training in the period of 12 weeks (3 times a week), Chaudhary & Jhajharia (2010), Attene et al. (2014), McCormick et al. (2015) that plyometric training for a period of 6 weeks, Khazai & Hematfar (2015) that plyometric training for 4 weeks (3x per week) leads to a significant increase in the height of vertical jump of female basketball players. Ramachandran & Pradhan (2014) found that the combination of plyometric training and dynamic stretching in the period of 2 weeks (3 times a week) leads to a significant increase in the height of vertical jump of female basketball players.

Agility is a motor ability which is very important for basketball. Motor structures of this type are very common in games, since, due to changes in the situation, the players are required to start fast, run quickly and change direction, as well as to stop quickly (Jovanović, 1999). By further analysis of Table 1 we can see that in all five analyzed studies that have examined the effect of plyometric training on the agility of female basketball players, a positive effect was found. Ramachandran & Pradhan (2014) found that the combination of plyometric training and dynamic stretching in the period of 2 weeks (3 times a week) leads to a significant improvement in the agility of female basketball players. Chaudhary & Jhajharia (2010) and McCormick et al. (2015) found that plyometric training for a period of six weeks, Dadwal (2013) that plyometric training for a period of 10 weeks (3x per week), Komal & Singh (2013)b that plyometric training for 8 weeks leads to a significant improvement in the agility of female basketball players.

In the equation of the success specification in basketball, the motor skill **speed** accounts for a significant coefficient (Jovanović, 1999). The analysis of the research in Table 1 showed that in all four studies, in which the mentioned capacity was studied, plyometric training had a positive effect. Bavli (2012) found that plyometric training for a period of 12 weeks (3 times a week), Dadwal (2013) that plyometric training for a period of 10 weeks (3x per week), Komal & Singh (2013)b that plyometric training for a period of 8 weeks, Chaudhary & Jhajharia (2010) that plyometric training for a period of 6 weeks significantly improves the speed of female basketball players.

In table 1 there are also three studies in which the authors investigated the effect of plyometric training on the **flexibility** of female basketball players. In all three studies the authors found a positive effect. Bavli (2012) found that plyometric training for a period of 12 weeks (3 times a week), Komal & Singh (2013)b that plyometric training for a period of 8 weeks, Chaudhary & Jhajharia (2010) that plyometric training for a period of 6 weeks brings a significant improvement in the flexibility of a female basketball player.

In two of three analyzed researches in which the authors investigated the effect of plyometric training on the endurance of female basketball players, a positive effect was found. Komal & Singh (2013)b found that plyometric training for the period of 8 weeks significantly improves the endurance of female basketball players. Urtado, Leite, Gimenes & Assumpção (2012) found that plyometric training for a period of 8 weeks (3x a week) leads to a significant decrease in the index of fatigue, actually it improves anaerobic endurance. In contrast to the mentioned studies, Dadwal (2013) found that plyometric training for a period of 10 weeks (3x per week) does not lead to a significant improvement in endurance.

Two analyzed studies have shown that plyometric training can have a positive effect on the situational-motor skills of female basketball players. Chidambara (2014) found that plyometric training for the upper and lower body, for a period of 8 weeks (3x a week) leads to a significant improvement of the situational-motor skills (SMS). In that study, for assessing SMS, Johnson Basketball Ability Test was used. Komal & Singh (2013)a found that plyometric training for a period of 8 weeks leads to a significant improvement of results in two of three Johnson Basketball Ability tests in which situational-motor skills were evaluated. The authors of these two studies concluded that plyometric training could have a positive effect on the situational-motor skills of female basketball players.

Comparison of different methods of plyometric training

McCormick et al. (2015) found that plyometric training that uses jumps in the sagittal plane (Psr) and plyometric training that uses jumps in the frontal plane (Pfr) lead to a significant improvement in explosive strength (long jump, high jump, *lateral hop test* (left), *lateral hop test* (right)) and agility (*lateral shuffle test* (left) and *lateral shuffle test* (right)). However, the authors also found that Psr leads to a significantly greater improvement in the height of vertical jump than Pfr, while Pfr leads to a significantly greater improvement on the tests of lateral hop (left) and lateral shuffle (left) than Psr. In tests of long jump, lateral hop (right) and lateral shuffle test (right), there were no significant differences between the two different programs of plyometrics. The authors conclude that it is best for basketball to use plyometric exercises in all areas in order to improve explosive power and agility.

Bavli (2012) found that the plyometric training in water as well as the land plyometric training for a period of 12 weeks (3x a week) lead to significant progress of maximal leg strength, sprint of 30m, height of the vertical jump and flexibility of female basketball players. The authors also found that there were no significant differences between the two different programs of plyometrics in their impact on the mentioned skills. Plyometric training in water reduces the risk of injury and changes the environment for training so it can prevent the occurrence of monotony due to repetitive activities on land (Miller, Berry, Bullard & Gilders, 2002). For this reason, coaches must carefully choose which method of plyometrics will be used in accordance with the set objectives.

Chang Hsu, Chen & Lin (2005) found that plyometric training that involves jumping from a bench of 50cm leads to a significantly greater improvement on tests *Counter Movement Jump* (CMJ) and *Continuous Jump* (CJ) than plyometric training that includes jumps from a bench of 30 or 40cm.

CONCLUSION

Based on this research, we can conclude that:

- plyometric training for a period of 4-12 weeks (3x a week), and a combination of plyometric training with weight training or dynamic stretching training can lead to a significant increase in the height of vertical jump of female basketball players,
- plyometric training for a period of 6-8 weeks (3x a week), and a combination of plyometric training with training of dynamic stretching can lead to significant improvements in the agility of female basketball players,
- plyometric training for a period of 6-12 weeks (3x per week) can lead to significant improvements in the speed and flexibility of female basketball players,
- plyometric training for a period of 8 weeks can lead to a significant improvement of the situational-motor skills of female basketball players.

By analyzing this research, we can also conclude that:

- plyometric exercises with jumps in the sagittal plane may have a different effect on the agility and explosive power of female basketball players compared to plyometric exercises with jumps in the frontal plane. It is best to use plyometric exercises in all planes in order to improve the explosive power and agility of a female basketball player,
- the aquatic and terrestrial plyometric trainings give equal results in the development of motor skills of female basketball players,
- plyometric training that involves jumping from a bench of 50cm leads to significantly greater progress of the height of vertical jump than plyometric training that involves jumping from a bench of 30 or 40cm.

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DYNAMICS OF THE LEVEL OF OXYGEN PULSE PHASES OF WORK AND REST AT STANDARD RUNNING LOAD PROGRESSIVELY INCREASE THE INTENSITY

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SUMMARY

The oxygen pulse is one of the most correctly quantitative criteria for assessing the aerobic capacity energetic at 800m running. Our analyze show us that the dynamics of oxygen pulse load and recovery has certain "critical" points which appear specific adaptation markers that characterize the individual functionalities of runners in 800m: zone of unlimited adaptation - oxygen pulse of 20 to 20.65 ml/beat – running at a speed of 3.8 to 4.59 m /sec. (from 26.31 to 21.79 seconds for 100 meters); zone of limited adaptation - oxygen pulse from 20.7 to 23 ml/beat - running at a speed of from 4.6 to 5.19 m/sec. (from 21.73 to 19.26 seconds for 100 meters); zone of impaired adaptation - oxygen pulse over 23.5 ml/beat and running speed of lower than 19.25 seconds for 100 meters).

Keywords: 800m, oxygen pulse, adaptation,

INTRODUCTION

One of the tasks of functional diagnostics in sport is a research of the changes that occur in cardiorespiratory system when carrying out training activities. In contemporary sports science and practice there is a number of proven effective methodological approaches that are related to the precise dosage of training effects. In our study we set such a task in one of the most interesting and prestigious athletics discipline - running at 800m. Its solution getting some of the issues on monitoring and evaluation of the current situation and the effectiveness of the specific running loads. New for sports theory and practice is that these results are a function of studies conducted entirely in terms of training with unique equipment. Similar studies in complex exercise , in this case running with progressive increases in speed have been made so far only in the laboratory , and test loads are modeled on the special simulation devices (tretmill or stationary bike). The research allows us to compare the results of laboratory and field studies and to improve the regulatory system for monitoring and evaluation of adaptation processes that characterize the effectiveness of the training process.

The aim of the research is to increase the effectiveness of the training process in running at 800m through disclosure and justification of the dynamics of the oxygen pulse, as a marker for determining threshold levels of running loads.

So the aim assumes the following tasks:

1. Study of the functional capabilities of competitors in running at 800m;
2. Analysis of changes in the level of oxygen pulse at a standard running load progressively increase the intensity;
3. Determination of quantitative values adaptation markers of respiratory activity.

METHODS

Object of the research are adaptation changes in the level of oxygen pulse due to the implementation of systematic training loads over a six-week pre-competition training mezocicle.

Subject of study were 20 men and 20 women athletes and competitors in running at 800m. Competitors were tested in natural conditions of sports training twice - the first time at the beginning of experimental stage and after its completion. The test which they performed is standard running load 6 x 1000 m in 3 minute passive pause progressively increasing speed.

The test is performed on a standard running track . The pace of the race was regulated with a special automatic pacemaker. During the testing were measured by telemetry computer complectation "K4" following indicators of activity of the cardiorespiratory system :

- Dynamics of the pulse frequency in the phases of load and rest;
- Dynamics of oxygen consumption (maximum and relative) in the phases of load and rest;
- Dynamics of the oxygen pulse in the phases of load and rest;

The results are correlated with the appropriate speed of running through statistical analysis of the respective correlations and regressions.

RESULTS

The oxygen pulse is one of the most correctly quantitative criteria for assessing the aerobic capacity energetic.

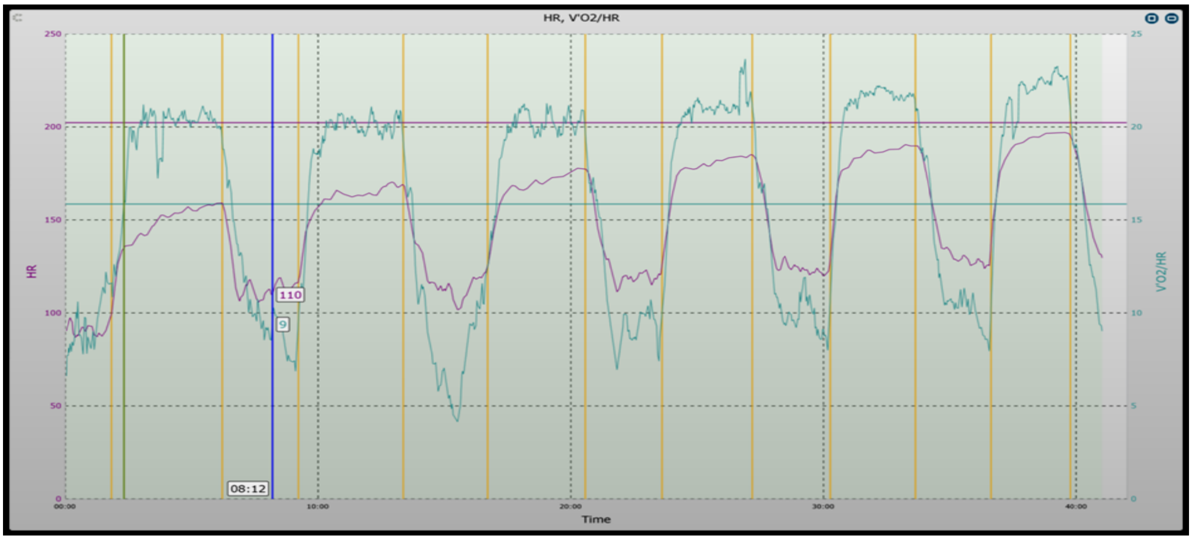

Figure 1. Dynamics of pulse rate and oxygen pulse during the test load 6x1000m.

His level affects the quantity of oxygen that enters in the muscles at one cardiac contraction. The results of our researches tracked the behavior of this indicator and its interdependencies with other motion and physiological indicators.

Presented in figure 1 record of comparative dynamics in the development levels of pulse rate and oxygen pulse impressed with some aspects.

For example, in the first three stages the level of work planned pulse rate increases constantly at the expense of the level of oxygen pulse, which marks a significant changing. That phenomenon is reason to believe that in this part of the test energy providing of muscle activity going on in terms of relative comfort in the general physiological condition of the body.

In the next three steps, however, this picture is changing as the consumption level of one cardiac intensive oxygen reduction increases. This in itself is an indication of difficulty in incoming process energy providing, i.e. significantly increased extremal conditions under which physiological systems works. It can reasonably be argued that the moment of intensive growth of the oxygen pulse indicates a significant change in adaptation requirements provoked by running load on the functional capacity of the body.

Therefore parameters (levels of VO2max, running speed, hart rate, oxygen rate and etc.) that underlie this change are showing as adaptive markers. They are unique to each individual, bearing date information for genetic potential, momentary opportunities, the nature of the changes due to the implementation of systematic training loads. Generally speaking they are performance criteria of the specific sports working.

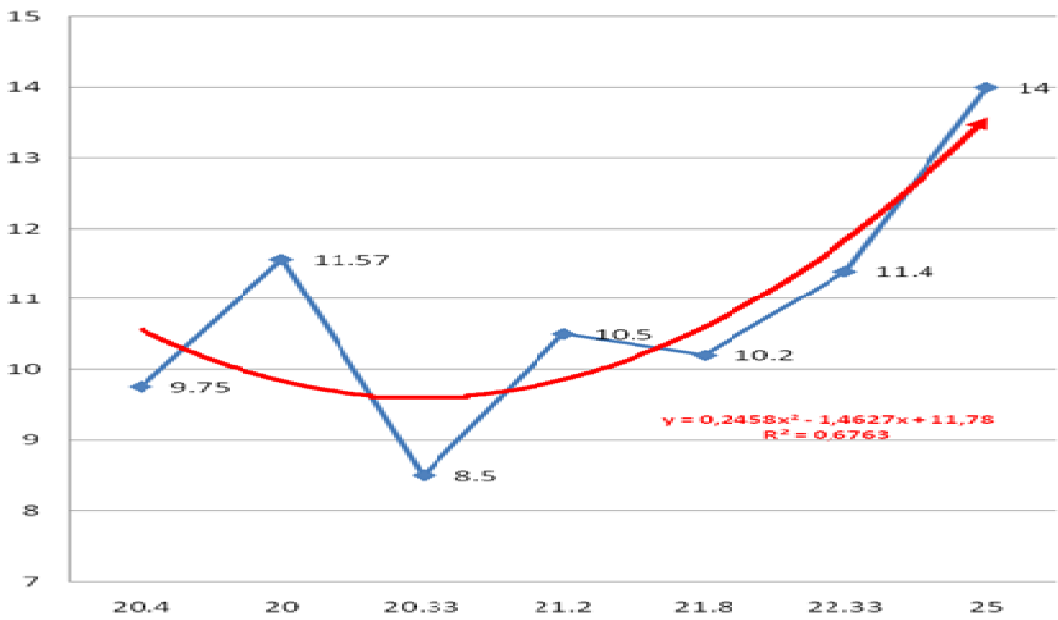

Figure 2. Dynamics levels of oxygen pulse phases of loading and recovery.

Presented in figure 2 graphic shows actual dynamics and theoretical trend described by the interdependence between the levels of oxygen pulse phases of loading and recovery. It developed on the basis of aggregated data of variation and correlation analysis of the results in the test (figure 1). As already mentioned this dynamic is characterized by several typical aspects.

In beginning of the test (the first three ran) working oxygen pulse is stable within the 20 to 20.44 ml for heart contraction. That, however, is the picture in the recovery phase. Here we observe a wide variation from 8.5 to 11.57 ml for heart contraction. As stipulated maximum value of 11.57 ml was registered after the first running, ect. at the beginning of the test. While it is the second largest ever in the whole test even after the last 1000 meters - 14 ml.

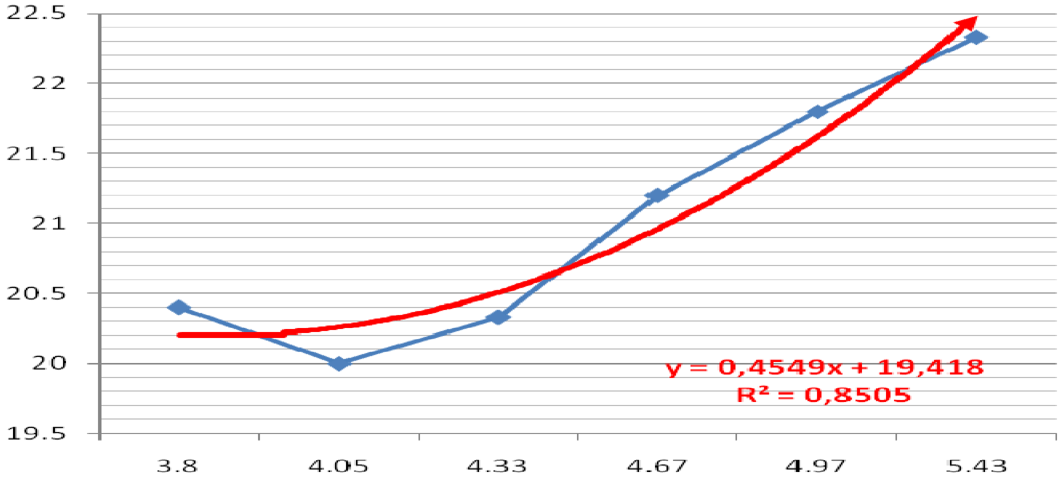

Figure 3. Dynamics of the oxygen consumption in accordance with the increase in running speed.

According to us this phenomenon is embedded in starting organization of the test, which does not allow pre-running warming up before the start of testing. This requirement puts additional burdens on working in the body to the specific requirements of the running loads. This appears to be confirmed by the next development results: at the next rest oxygen pulse (after the second running-) is already 8.5 milliliters, which even lower than the baseline of 9.75 ml. While data from the operating values of the oxygen rate in the first three runs of a 1000 m demonstrate stability within the 20 to 20.44 ml per beat. During the fourth run this stability is impaired in which the rate of the oxygen pulse is increased by approximately one unit of 21.2 milliliters of 20.33. In the next run we observe a planned increase of this level, as follows 21.8 and 22.33 ml.

This analysis confirms our prediction that the dynamics of oxygen pulse load and recovery has certain "critical" points which appear specific adaptation markers that characterize the individual functionalities of runners in 800m. The identification of their quantitative performance analysis suggests correlation between oxygen pulse and changes in the intensity (speed) of the running loads. The graphical expression of that dependence is presented in figure 3. The two curves in the graph show the actual results of the processing of the results (broken line) and a polynomial expression of the theoretical developments (exponential curve).

CONCLUSION

1. Increasing the effectiveness of individual training aimed at improving specific sports working requires daily operational control of the activities of the cardiorespiratory system by heart rate monitor.
2. Processing of data daily heart rate monitor results suggest the development of personal model levels of adaptation markers (aerobic and anaerobic pulse VO2max, oxygen pulse and critical speeds running work).
3. The creation of individual criteria for assessing the effectiveness requires planning mesocicle system function control, as it should be fixed specific deadlines for conducting laboratory and field studies.
4. The comparative analysis of ratios of oxygen pulse phases of load and rest allows us to differentiate the following three areas of adaptation characteristic:

- Zone of unlimited adaptation - oxygen pulse from 20 to 20.65 ml/beat running at a speed of 3.8 to 4.59 m/sec. (from 26.31 to 21.79 seconds for 100 meters).
- Zone of limited adaptation - oxygen pulse from 20.7 to 23 ml/beat. Running at a speed of from 4.6 to 5.19 m/sec. (from 21.73 to 19.26 seconds for 100 meters)
- Zone of impaired adaptation - oxygen pulse over 23.5 ml/beat and running speed lower than 19.25 seconds for 100 meters).

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MOTORIC POLYGON AS AN INSTRUMENT FOR SELECTION IN GYMNASTICS

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SUMMARY

A sample of 116 primary school pupils in Nis, aged eight years, set out the standards of selection for gymnastics. Polygon skills was used in the system of competition in the School Sports called "Small Olympic Games". From the total sample of respondents, after determining norms or criteria, the children has been scored, even 51.72% of the children managed to qualify for further process in gymnastics. Of the total number of 56% of boys has acquired a condition for further selection and 46% of girls. Based on these results it can be concluded that the polygons are good as a means of rapid selection of potential candidates for sport gymnastics, but require subsequent verification of physical tasks in order to engage in gymnastic training process. This Polygon is necessary for popularization of the gymnastics sports.

Keywords: polygon, motor tasks, differences, school children, school sports

INTRODUCTION

Educating young people in a particular social system depend on a number of educational institutions, but also from the efforts of families to direct their children to appropriate psycho-physical development. The level of development of a society can be evaluated on the basis of achievements that this society has made in his community and beyond. Physical culture is a social area of life that takes account of the physical and mental health of their society. As the sport in our country is viewed through the integral concept of physical education, basics of the sport as a segment of development adopted in youth. Depending on the type of sport and specifics must be taken of the sensitive stages in the development of the child and all motor manifestations which are manifested in this period. Sports competitions on the other hand represent a way to determine or compare their own contribution to the athletes in the community where he lives. The training process in sport is focused very specifically on the development of only those skills that should result the greatest sports result. According to the etymology of the word "polygon" is a military term especially furnished, equipped and programmed surface in closed and open spaces with a mandate to form a certain motor skills and abilities (Hmjelovec, Kalić, Hmjelovec, 2005). The school ground is used as a system of barriers with the successive execution of a number of physical tasks in order the development of certain psychomotor skills. In some societies polygon serves the purpose of transformation or development of certain stylized movements or in the first stage in gymnastic classes as a means of preparing the body for the load in training. Each sport in order to achieve the highest sports results has determined the system on a basis of a selection of the best resources that should achieve the planned results in a sport branch. Selection in artistic gymnastics is implemented differently, all depends on the form of organization, trained personnel and material basis in a particular environment. Orientation and selection of children for sport gymnastics implemented as early as 5-6 years of age, in the framework of specialized gymnastics school. Due to the system of education and material investments in our midst these gymnastic school are modified in sports school, which offer various program development skills and agility children. Through these sports schools experts is possible through different systems of polygons to select a potential children, which might meet the criteria for first phase of mass selection in gymnastics. In the education system "Little Olympics" represent a system of polygons, which is designed for ages 6,7 and 8 years where the group competition team consisting of five boys and five girls, improve motor skills of children and their spirit to compete. Through these polygons it is possible to identify specific motor abilities that are needed for sport gymnastics.

Motor skills are called those skills involved in solving motor tasks and conditional on the successful movement, regardless of whether they are acquired skills training or not. The basis of motor abilities make unique, but also very complex and integral movements (Malacko, 1982). The structure of motor abilities is interpreted in two ways: factors of action and factors of topological type. The factors of action types include: power, speed, flexibility, balance and accuracy. Factors of topological types have been expanded with the factors divided by region: arms and shoulder girdle, trunk and legs. According to the specification equation of success in gymnastics, which was hypothetically set by Petkovic (1996) and practically determined Todoroski (1998), the highest value have coordination bodies and speed of learning complex motor tasks. As the coordination abilities important criterion for dealing with gymnastics and discover their latent structure presents a challenge for further research. Polygons applied through polygons skills in the lower school age is the result of several years of work with selected gymnasts younger school age. Gymnastic selection in the first part of training time polygons applied skills. Proje (1982) dealt with the problem of the structure of complex tests to measure agility, determination of metric characteristics and practical application of a sample of 81 boys aged 7-9 years. Tested pupils of one school year to practice in school gymnastics sessions. They are designed measuring instruments for alternating movements polygon, polygon orientation in space, polygon overcoming obstacles, agility training ground and training ground complex movement tasks. It was found that the applied test motor tasks understandable and appropriate for the test population that are sensitive enough to test the homogenity of a very high measure of representativeness lower but acceptable. Hmjelovec, I. Kalić & Hmjelovec D. (2005) investigated the structure and impact of the polygon as a tool for the development of psychomotor skills. Application of polygon data in the examples of polygons with different tasks in athletics, basketball, gymnastics and football that can be realized in terms of school halls. The examples and polygons for preschool children, as well as their application in other areas of life: education, sport, kinesitherapy, recreation, snow. Rubeša, Mason & Franc (2006) constructed a motor polygon with different kinesiology composition to children and parents and found that after a certain experimental program motor skills are positively transformed and both children and parents. Peric (2008) investigated the impact of polygons on the development of situational - motor coordination skills and speed of performing complex motor tasks in young gymnasts aged 7 to 10 years. The experimental program that was implemented in the first phase of gymnastic training time, three different types of polygons skills after 12 weeks resulted a statistical difference between initial and final measurement (.00).

METHODS

Subjects

The subject of this research is Polygon in the system of competition of elementary school children of the Republic of Serbia. The aim of the work is to determine the differences in agility with boys and girls aged 8 years of elementary school "Sv. Sava "in Nis. The main task of this paper is that after the results obtained determine the difference between boys and girls first grade of elementary school in Nis on polygon; to establish norms for evaluating the skill polygon, so that it could determine whether the polygon skills served as a tool in the selection process in gymnastics. As a research hypothesis H_1 - it is assumed that there is a statistically significant difference in favor of boys on the test polygon skills.

Procedure

This research participate school boys and girla of elementary school "Sv. Sava "in Nis, and they Polygon first time practise. The sample consists of 116 children, of which 62 school boys (DEC) and 54 school girls (DEV), age 8 years (± 0.6 months). The survey was conducted by measuring the school hall where he was appointed Polygon (POL). The specificity of this competition is that one team consists of 10 athletes (five school boys and five school girls). Competitors must so rapid, accurate and co-ordinated execut polygons because changes contestants performed at the start-goal. The racer who finished polygon handing the baton to a competitor who is moving. Time is measured in seconds and determines the winner, and the sum of all time determines the winner of a team. Every mistake is penalized by the judges in the contest and added to the team faults, which are later recorded in the final ranking. Longitude of polygons that school children needs to cross is 40m meters. Polygon contains the following tasks: roll forward on the mat (2m), Running 10 meters, transitioning the Swedish bench leg hop (4m), Slipping through the window of the Swedish crates passing on the long side (3m), two foot long jump from the mat, Wearing medicine weight 2kg, 5m length and putting in a box (5m), shooting balls at a target, set on sloping ground, 1x1m away 6m (target to hit only one ball on the line and throws are five tennis balls). The layout and construction of Polygons proposed by the Alliance for School Sport of the Republic of Serbia, where the "Small Olympic Games" was implemented for more than 20 years.

Statistical analysis

As a method of processing data will be used basic statistical parameters, central and dispersion parameters. To determine the difference between the results of boys and girls in the realization of the program of polygons will be used t-test for small independent samples. Data processing will be carried out program Statistics 6.

RESULTS

The research results of basic statistical parameters are given in Tables 1 and 2, Table 3 shows the results of T-test for small independent samples. Table 4 shows the norms of polygons that have been proposed as a criterion for the selection of children for sport gymnastics. Significance of T-test will be determined at the level of 0.00 -0.05.

Table 1. Basic statistical parameters school boys

Variables	N	Mean	Min	Max	Range	Std.Dev.	Error	Skew	Kurt
POL	62	37.63	21.53	66.45	44.92	10.949	1.390	0.8927	0.2393

Table 2. Basic statistical parameters girls

Variables	N	Mean	Min	Max	Range	Std.Dev.	Error	Skew	Kurt
POL	54	40.43	24.37	60.69	36.320	9.764	1.329	0.3203	-0.6419

Table 3. Differences in Polygon skills in boys and girls

Variables	Grupa	N	Mean	Std.Dev.	t-value	df	p
POL	*DEC*	62	37.63	10.949	-1.44432	114	0.151391
	DEV	54	40.43	9.764			

Table 4. Norms for Polygons skills for future research

Scoor	5	4	3	2	1
DEC	21,53≥	≤27,00	≤32,47	≤37,94	≥37,95
DEV	24,37≥	≤29,25	≤34,13	≤39,01	≥40,43

DISCUSSION

Table 1 shows that the best result among the boys, is 21, 53 seconds and the lowest 66.45 seconds, which concludes that the sample of respondents strongly inhomogeneous, which can be seen from the results (44,92). This was expected, because the respondents class of physical education conduct teachers, so that none of the identified barriers or motor tasks were not practiced. It is expected that there are certain children who are already involved in a system of sports schools so that they were familiar with some of motor tasks with better results. Values Skjunisa is 0.89 which indicates that the task this group of respondents were overweight, which is reflected in the wide range of results.

An examination of Table 2 shows that the best result of school girls is 24, 37 seconds, a little weaker than boys (21,53sek) and less 60,69sek, which is significantly better than boys (66,45sek). Girls are more homogeneous than boys, as it can be seen from the results (36,32). This group task was considerably easier, as it can be seen from the results (0.32).

Table 3 presents the statistical differences between boys and girls in skill polygon, which shows that there are no statistically significant differences between the results of the skill polygon (r = 0.14).

Table 4 shows the Norms of skill polygon for selection potential candidates that can access a further selection process in gymnastics. Norms are established based on the average values obtained for school boys and girls so that the result of the mean value and the lowest result is 1 point and the best result is the minimum score is 5 points. These average values are taken as the criteria for the creation of the standards, according to which children are selected and scoored. The minimum score is added ½ standard deviation to determine the norms for selection.

CONCLUSION

Based on these standards, out of 116 children, after scoring, it was information that 60 children (51.72%) failed to qualify for further breeding in gymnastics. From 62 boys qualify for 35 (56%) and 54 girls criteria has passed 25 of them (46%). This commitment to further selection must be conditionally accepted, because the mass selection in gymnastics has established battery of tests that need to be accessed, but this polygon has served as one of the means that can be a quick indication of selection of children some of the necessary aptitude for this sport. In addition to skill and agility that this training provides mastering certain tasks (Rolls forward or backward, wriggling, jumps, carrying medicine), the polygon data and the accuracy and throwing balls at a target, and of course speed, although the speed is not the primary indicator for sport gymnastics. Research Proje (1982), Peric (2008), Hmjelovec et al. (2005) identified a positive impact on the transformation of the polygon motor skills. Hypothesis H_1 which assumes that there is a statistically significant difference in favor of boys on the test polygon skills can be completely ruled out, because the earlier assumption that boys are more agile was not confirmed. Although little is known about such a polygon that is used in the school plays, it is necessary that primery school teachers of physical education actively take part in its implementation. With regard that physical education in elementary schools in District of Nish implementing teachers, the professors needs to cooperation with them because it is necessary children to adopt proper movement habits. It is not enough just to set pologon and implement it. It takes every task at the training ground to practice individually, and in particular the need to show correct methodological approach of some simple exercises on the floor (rolling forward and back as well as two-leg hops) and to be adopted by the technique of movement. On Polygon proper technique, fast overcoming obstacles are very important and if you cross a motor task to someone else or poor technique, the overcoming are penalized. This Polygon is necessary for popularization of the gymnastics sports. This research has shown that a given polygon accessible for further research and requires better cooperation of teachers, physical education teachers with sports experts in the sports school and clubs due to the popularization of gymnastic contents which lead to normally growth and development of children, also children can be choozen and selected to participate in the gymnastics competitions of different levels (A, B or C program) that are in the system of competition Serbian Gymnastics Association.

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EFFECTS OF MEDICINE BALL TRAINING ON EXPLOSIVE STRENGTH IN COMPETITIVE VOLLEYBALL PLAYERS

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SUMMARY

The aim of this research was to determine the effects of medicine ball training on explosive strength in competitive volleyball players. Twenty four male volleyball players participated in this study. The players were members of Volleyball teams that compete in second Division League in Serbia. Upper-body explosive strength was estimated using an overhead medicine ball throw, seated medicine ball throw and lying medicine ball throw, while spike and block jump and standing broad jump were used for jumping performance. The medicine ball group trained twice per week on nonconsecutive days for six weeks under monitored conditions. Changes in the lower-body and upper-body muscular power of players over the training period were compared using one-way univariate analysis of variance. Participants significantly improved ($p < 0.05$) their performance from pre- to post-training on all measures with the exception of the seated medicine ball throw and lying medicine ball throw. These results demonstrate that specific medicine ball training, as part of the overall training process, can be considered a useful tool for the improvement of jumping ability. Therefore, it is highly recommended to use the Medicine ball training because it allows complex volleyball movements to be performed explosively with greater resistance than that seen during regular sports competition in a specific manner.

Keywords: team sport**,** impact, power, abilities

INTRODUCTION

Volleyball is one of the most popular sports in the world. Regarding that fact many studies have been conducted in an attempt to understand the better program training required to develop total body performance by a volleyball player (Marques, van den Tillaar, Gabbett, Reis, González-Badillo, 2009**).** Moreover, competitive volleyball is a demanding sport that requires speed, agility, upper and lower body strength, and maximal aerobic power. In Volleyball, players aim to improve technical, tactical, psychological, and physical qualities. During the pre-season, training emphasizes on physical fitness improvements, whereas during the in-season period the emphasis is mainly on making tactical and technical improvements while maintaining physical fitness. Training programs and methods have been developed and tested to improve player fitness and skills with differing results (Noyes, Barber-Westin, Smith, and Campbell, 2011). Investigations vary widely in the populations studied, duration of training, exercises and drills selected, and outcome measures. From both a research and coaching viewpoint, there is no gold standard for training professional competitive volleyball players to improve all of the factors required to enhance player performance.

In addition to technical and tactical skills, muscular strength and power are the most important factors that give a clear advantage for successful participation during competitions (Marques, Gonzalez-Badillo, and Kluka, 2006.). It is believed that to improve their volleyball performance, players must arrange specific volleyball conditioning with some additional resistance and sprint and agility training (Hakkinen, 1994). During the preseason, coaches usually implement a conditioning and training routine in an attempt to maximally prepare their athletes for the upcoming competitive season. Coaches have a limited amount of time to work with their athletes during preseason. Given the short period of time, it is questionable whether athletes can be trained at high intensities and yet properly rest and recover between training sessions to fully achieve the desired effects.

Unlike traditional resistance training on weight machines, some medicine ball exercises require the body to function as a unit instead of separate parts. In addition, training with medicine balls provides a unique type of resistance that can be used for a variety of exercises that can be performed at different movement speeds. Moreover, it is likely that the ability of medicine ball training to enhance motor performance skills is due to the ability to create exercises with medicine balls that mimic natural body positions and movement speeds that occur in a game situations (Faigenbaum & Mediate, 2006). Gabbett et al, (2006) failed to improve upper-body muscular power (overhead medicine-ball throw) following a skill-based training program in talent-identified volleyball players. However, Gabbett (2008) founded in male junior volleyball players that skill-based conditioning games induce improvements in vertical jump, spike jump, speed, agility, upper-body muscular power (Medicine ball throw), and estimated maximal aerobic power.

The use of medicine balls in sports training is growing as coaches see the wide range of skills that can be trained or simulated. In order to make training programs more sport specific, coaches are continuously finding new ways of using medicine balls to train the specific physiologic or biomechanical variables required for success in their particular sport (Stockbrugger and Haennel, 2001). At present, there is a limited data available about the effects of medicine ball training on fitness, and sports performance in volleyball players. While researchers have investigated the effects of different modes of resistance training and plyometric training on volleyball players published research investigating the effects of medicine ball training on muscular fitness seems to be lacking. Therefore, the aim of this research is to determine the effects of medicine ball training on explosive strength in competitive volleyball players. The authors hypothesized that this program might significantly improve explosive strength in competitive volleyball players.

METHODS

Subjects

Twenty four male volleyball players participated in this study. The players were members of Volleyball teams that compete in second Division League in Serbia. Two participants had international experience, and 2 participants were candidates for the under-16 National team. Descriptive characteristics are presented in Table 1. All the participants provided written consent after being informed of the test protocol. The protocol of the study was approved by the Ethical Committee of the Faculty of sport and physical education, University of Nis, and according to the revised Declaration of Helsinki. Each player had at least 4 years of training experience, corresponding to 2-hour training sessions, and at least 1 competition per week. Each athlete performed a standardized 15-minute warm-up consisting of general movements and dynamic and static stretching. After general warm-up, the players performed assessments of vertical jumps, standing broad jump and medicine ball tests in random order. After the training program, the subjects were instructed to perform the tests in the same order as they did before the training program. Because the ethical considerations discussed by Kraemer (2005) and the difficulties expressed by Marques et al. (2008), it was not possible to include a control group which avoids training.

Table 1. Descriptive characteristics of the subjects

Age (y)	Training experience (y)	Body height (cm)	Body weight (kg)	Standing reach height (cm)
22,6±2,01	8.4±3.4	188,15±7,44	71,84±10,45	242.3±3.2

Procedures

Beside the results, basic anthropometric parameters (body height and body weight) were registered in the study protocol. The initial testing took place before the beginning of the second part of season period while the final testing was performed after 6 weeks of intervention with the medicine ball training method. All study procedures took place at a indoor athletic facility. All participants took part in one introductory session during which time proper form and technique on each fitness test were reviewed and practiced. During this session research assistants demonstrated proper testing procedures and participants practiced each test. Participants were asked not to perform any vigorous physical activity the day before or the day of any study procedure. The same researchers tested and trained the same participants and the fitness tests were performed in the same order with identical equipment, positioning, and technique. Before each testing, the participants performed a standard 20-minute warm-up. Standard warm up protocol consisted of 10 min of warm up running and 10 min of dynamic stretching and 5 x 30m of running exercises.

Spike and block jump performances

For the standing reach, while wearing their normal volleyball footwear, players were requested to stand with their feet flat on the ground, extend their arm and hand, and mark the standing reach height while standing 90° to a wall. Players were encouraged to fully extend their dominant arm to displace the highest vane possible to determine their maximum standing reach height. The measurement of the standing reach height allowed for a calculation of the relative jump heights on each of the jumping tasks (absolute jump height (cm) – standing reach height (cm) = relative jump height) (Sheppard et al, 2009).

Spike (SJ) and block (BLJ) jump performances for volleyball players depend heavily on the height at which these skills are performed above the net and are determined by not only the capacity of the athlete to raise vertically his center of gravity, but also his stature and standing reach. In this particular case, specific tests would provide a further understanding of the training-induced adaptation. For the SJ, the standing reach was determined as the maximal distance between the fingertip of the attack hand and the ground, while standing 90° to a wall. The SJ was measured from a running lead (2- or 3-step approach) by using a basketball backboard marked with lines 1 cm apart with a 1-minute rest interval between them (Hasegawa, Dziados, Newton, Fry, Kraemer, and Hakkinen, 2002). For the BLJ, the standing reach was determined as the maximal distance between fingertips of the block hands and the ground, while facing the wall. The BLJ jumps started from a standing position with the hands at shoulder level and arms raised from the start position without extra swing. All tests used the same observer who was situated on a volleyball referee stand placed 2 m from the backboard. Both jumps were recorded as the best of the 3 attempts (Stanganelli, Dourado, Oncken, Mançan, da Costa, 2008).

Standing broad jump (SBJ) was used for assessing the explosive power of the lower limbs. The players were instructed to stand behind a line and jump as far as possible—allowing arm and leg countermovement. The distance was measured from behind the line to the back of the heels at landing.

Upper-Body explosive strength

Medicine Ball Testing

Upper-body explosive strength was estimated using an overhead medicine ball throw, seated medicine ball throw and lying medicine ball throw. Medicine ball throws were performed using the 21.5-cm diameter and 3-kg rubber medicine balls (Tigar, Pirot, Serbia). All subjects were introduced to the testing on familiarization session. The skin of the medicine ball was lightly dampened (magnesium carbonate) to leave an imprint on the floor where first contact was made and to ensure precise measurement of the throwing distance. Distance was measured from the base of the bench to the closest edge of the medicine ball imprint.

Overhead medicine ball throw (MEDST)

The test was conducted with players standing one step behind a line marked on the ground facing the throwing direction, with a 3-kg medicine ball held in both hands behind the head. Players were instructed to plant the front foot with the toe behind the line and to throw the medicine ball overhead as far forward as possible. Each throw was measured from inside the line, to the nearest mark made by the fall of the medicine ball. Throwing distance was measured to the nearest 1 cm, with the greatest value obtained from 3 trials used as the overhead throw score (Gabbett & Georgieff, 2007).

Medicine Ball Put (MEDS)

The medicine ball put approximated a basketball chest put, completed from a sitting position. Each subject was seated on an adjustable chair with back oriented vertically against a back support, thighs horizontal, knees flexed at 90°, and ankles fixed behind swivel pads at the base of the chair. Subjects were secured to the bench with elastic strapping placed around the trunk and the backrest at midchest level under the axillae. This position and mode of stabilization minimized trunk movements during the put. Subjects were instructed to hold the medicine ball in their laps with both hands, bring the ball up quickly to touch their chest at about nipple level, and then explosively perform a chest type pass, pushing the ball outward and upward at an angle approximately 30° above horizontal. The same instructions and demonstrations were given to each subject before each test (Vossen, Kramer, Burke, and Vossen, 2000).

Lying medicine ball throw (MEDL)

The subjects were instruct to lay down on their backs and held a 3-kg medicine ball on the floor above their head with the arms fully extended. The shoulders were on the zero-line. The throwing action was similar to that used for a soccer throw-in. The ball was thrown forward as vigorously as possible, while the head was kept on the floor. The best of the consecutive trials was recorded as the final result (to the nearest 1 cm). (Tomljanovic, Spasic, Gabrilo, Uljevic, Foretic, 2011).

Training program

The exercise group trained twice per week on nonconsecutive days for six weeks under monitored conditions. A physical fitness specialist discussed and demonstrated proper medicine ball training procedures during one week, and players had an opportunity to ask questions. In addition to the specific training each group undertook technical and tactical training. The duration of the training sessions was recorded, with sessions typically lasting 90 minutes. Besides these sessions, 2 moderate to high-intensity tactical and skills training sessions were performed. During the 6-week follow-up, the team played 3 friendly preseason matches. Each training session consisted of a warm-up period (15-20 minutes) and conditioning phase (20 to 30 minutes), following 30-40 minutes of low to moderate intensity technical training. During the warm-up period subjects performed a series of six to ten low to moderate intensity exercises with a 2-3 kg leather medicine ball. During the medicine ball conditioning phase, subjects performed a variety of medicine ball exercises that progressed from simple to complex as their competence and confidence improved. The various medicine ball conditioning exercises included: lower body (e.g., underhand squat throw, backward overhead medicine ball throw), upper body (e.g., shoulder press, medicine ball slams and throws), stability (e.g., single leg toss), reaction (e.g., wall chest pass). Most medicine ball exercises involved lifting and throwing. A summary of the Medicine ball training program is in Table 2.

Table 2. Medicine ball training program employed between week 1 and week 6.

Medicine ball training guidelines			
	Week 1-2	Week 3-4	Week 5-6
Load	3 kg	3 kg	4 kg
No. exercise	3-5	4-6	4-6
No. reps per set	10-20	12-25	12-25
No. sets per session	3-5	3-5	3-5
Rest interval	2-3 min	2-3 min	2-3 min
Frequency	2 x per week	2 x per week	2 x per week

Statistical analysis

Descriptive statistics were calculated for all experimental data. The Kolmogorov-Smirnov test was used to test if data were normally distributed. Changes in the lower-body and upper-body muscular power of players over the training period were compared using one-way univariate analysis of variance. For all comparisons, a level of $p < 0.05$ was considered to be statistically significant.

RESULTS

The Kolmogorov-Smirnov test showed that data were normally distributed. Participants significantly improved ($p < 0.05$) their performance from pre- to post-training on all measures with the exception of the seated medicine ball throw and lying medicine ball throw (Table 3). Compared with pretraining, there was a significant ($p < 0.05$) improvement in all lover body tests. Spike and block jump performance improved significantly with $p < 0.01$, while the results for Standing broad jump show statistically significant difference ($p=0.023$) pre to post training (Table 3).

There were no significant differences ($p >0.05$) between pretraining and posttraining for seated medicine ball throw and lying medicine ball throw. However, a statistically significant difference pre- to post-training ($p < 0.05$) was found for Standing medicine ball throw.

Table 3. Mean ± SD results of different parameters: jumping and throwing performance before the experimental period (initial) and after the 6-week experimental period (final).

Tests	Initial (Mean ± SD)	Final (Mean ± SD)	P value
Block jump	42.10± 2.34	48.25± 2.56	0.00*
Spike jump	51.63± 4.70	59.26± 8.72	0.00*
SBJ	215.29± 4.65	218.21± 3.91	0.023*
MEDL	6.82± 1.23	7.31± 1.09	0.151
MEDS	5.07±0.65	5.39± 0.68	0.102
MEDST	8.03± 1.46	9.24 ± 1.42	0.006*

* Significant difference p < 0.05 between initial and final testing

DISCUSSION

The present study investigated the effect of a medicine ball training program on explosive strength in male competitive volleyball players. Our results show that the medicine ball training was effective at increasing most performance parameters in volleyball players. Significant improvement was observed in all jumping tests for training group. The importance of the capacity for attacking and blocking could be seen in the fact that it provides the athletes with better conditions to perform much higher skills above the net, where decisive points are scored, and are determinants for the final result of the volleyball match (Beal, Peppler, and Kessel, 1990). Sports like volleyball may require the generation of explosive power from an airborne position, as with an attack or jump service (Cisar, and Corbelli, 1989). According to Stockbrugger and Haennel, (2001) using a technique such as medicine ball training may help to improve performance by integrating both lower-body and upperbody training. This was the case with our results, which showed significant improvement in spike and block jump following six weeks of medicine ball training. Modern volleyball games are faster and with a lot of back row attacks conducted from opposite and outside hitters. Therefore, it was expected that the players would improve their results in SBJ.

After 6 weeks of medicine ball training, there was increase in one medicine ball tests, standing medicine ball throw (Table 3). The improved upper-body power in response to training may reflect the highly repetitive nature of selected explosive volleyball skills (e.g., blocking, spiking, serving). However, it is unclear why these skills failed to improve seated medicine ball throw and lying medicine ball throw. Possible reason the medicine ball training may not have improved throwing distance because it did not improve the neuromuscular qualities of force output and rate of force development. Perhaps the overload on the muscle when accelerating a 3-kg medicine ball is not enough to induce a training adaptation. This finding is similar to that of Kaneko et al. (1983), who determined that the greatest strength increases are produced using heavier loads and that strength increases are minimal when using light loads, even if they are accelerated rapidly. Another reason may be the nature of the throwing tests. Seated medicine ball throw and lying medicine ball throw are conducted while the whole body is isolated except for the hands, while during the standing medicine ball throw test there is no isolation for the rest of the body.

A limitation of this study is that it doesn't include control group. Thus, the present results are limited to Second Division volleyball players and may not be applicable to highly skilled, elite volleyball players. Therefore, further research is required to determine if medicine ball training can improve measures of fitness after a similar training period in highly skilled elite volleyball players. Notwithstanding these limitations, practical importance of incorporating medicine ball training into a competitive volleyball players programs should not be overlooked.

CONCLUSION

These results demonstrate that specific medicine ball training, as part of the overall training process, can be considered a useful tool for the improvement of jumping ability. This kind of training failed to improve the upper-body explosive strength. However, future studies should involve different weights and use both single-handed and 2-handed medicine ball throws in preferably all planes and axes of movement in order of improving the upper-body explosive strength. The Medicine ball training allows complex volleyball movements to be performed explosively with greater resistance than that seen during regular sports competition in a specific manner. Moreover, the use of Medicine ball training exercises represents an inexpensive strength training strategy with high practicability. Volleyball coaches could use this information in the process of planning the pre and in-season training. For proper volleyball conditioning, coaches could make training more specific in such a way that the transfer of training effects to game efficiency will be faster.

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RELATIONS OF MORPHOLOGICAL CHARACTERISTICS AND MOTOR ABILITIES IN U-15 SOCCER PLAYERS

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SUMMARY

Thirty elite U-15 soccer players were subjected to testing using the group of 9 morphological and 9 motor tests, with the aim of determining relation between morphological characteristics and motor abilities. The predictor group of variables consisted of 9 morphological characteristics evaluation tests: 5 tests for body mass and volume evaluation, 1 longitudinal skeleton dimensionality test, and 3 subcutaneous adipose tissue evaluation tests. The criterion group of variables consisted of 9 basic motor tests. After the preliminary processing procedures, the relations between predictor and criterion group of variables were determined using a series of regression analyses. Significant and positive correlations were determined between certain morphological characteristics and motor abilities. The obtained results confirm the results of previous research on the negative impact of body mass and volume on the non-specific and specific motor abilities of soccer players.

Keywords: soccer, anthropometric characteristics, basic motoric ability; regression analyses

INTRODUCTION

Soccer is one of the most popular games in the world. According to structural complexity of sports classification, it belongs to the group of complex sports activities, with other team sports (basketball, volleyball, handball etc).

The soccer-specific training in young players may start as early as at 8 years of age with the first competitions starting not much later. However, identifying talent for soccer and other team games is more complex than in individual sports where a single objective measure of performance exists.

Success in soccer is dependent on a variety of factors including the physical characteristics and physiological capacities of the players, their level of skill, their degree of motivation, and tactics employed by them against the opposition. Some of these factors are not easily measured objectively, but others can be tested using standardized methods and can provide useful information for coaches. Most of the previous research aimed toward profiling and talent identification has been focused on the physical performance and skills of young soccer players (Bunc and Psotta (2001), Gil et al (2007), Reilly, Bangsbo and Franks (2000)). The studies of anthropometric dimensions, physical performance, and soccer-specific skills of young players have provided partly consistent findings.

The research of anthropometric measures and motor abilities of young soccer players was a subject of research of other authors (e.g. Tumilty et al. (1993), Chin et al. (1994), Bunch et al. (2001), Casajus (2001), Erceg, Laštre and Lisica (2005), Andabak (2010)).

The aim of this research was to determine (partial and global) relations between certain motor characteristics and motor abilities of U–15 soccer players.

METHODS

The sample of examinees was represented by U–15 soccer players of FC "HAJDUK" from Split (Croatia). The group consisted of 30 boys, practicing soccer regularly in average 6.9 years, with 4 practices and 1 competitive match per week.

The sample of anthropometric variables consisted of group of 9 anthropometric measures: *Body height, Body mass, Elbow diameter, Knee diameter, Contracted upper arm circumference, Lower leg circumference, Dorsal skinfold, Abdominal skinfold* and *Lower leg skinfold*.

The sample of motor variables consisted of group of 9 motor tests: *10 m, 20 m and 30 m fast running, 9-*

3-6-3-9 test, Slalom test, Zigzag test, Long jump, High jump (Sargent test) and *Throwing medicine ball jumping from squat from chest (total body power).*

The methods of data processing included the calculation of descriptive statistic indicators of the distribution of 9 anthropometric measures and 9 motor abilities tests: arithmetic mean (AM), Lowest value (Min), Highest value (Max), standard deviation (SD) and determining MaxD value for calculation of significant deviation from normal distribution of variables by using Kolmogorov-Smirnov test (KS test). Linear correlation analysis was used in order to determine partial relation between morphological characteristics and motor abilities. A series of regression analysis was used to determine global relation between morphological characteristics and motor abilities.

RESULTS AND DISCUSSION

Table 1. Descriptive statistic parameters of applied variables

Variables	AM	Min	Max	SD	Skew	Kurt	maxD	K-S p
Body height	175.89	154.20	195.00	8.61	0.08	0.73	0.13	p > .20
Body mass	62.12	41.10	83.80	8.72	0.22	0.99	0.12	p > .20
Knee diameter	9.76	9.00	10.80	0.41	0.88	0.69	0.17	p > .20
Elbow diameter	6.53	5.80	7.30	0.34	-0.07	-0.10	0.10	p > .20
Upper arm diameter	30.04	25.00	34.50	2.29	0.14	0.34	0.15	p > .20
Lower leg diameter	36.63	30.50	40.80	2.01	-0.56	1.84	0.13	p > .20
Dorsal skinfold	8.23	6.00	10.60	1.10	0.14	-0.38	0.09	p > .20
Abdominal skinfold	5.75	3.80	10.00	1.52	1.48	2.09	0.19	p < ,20
Lower leg skinfold	8.09	4.80	12.60	2.03	0.43	-0.62	0.10	p > .20
Standing long jump	226.67	192.00	272.00	17.88	0.42	1.07	0.14	p > .20
High jump	43.97	31.00	56.00	5.74	0.07	-0.18	0.16	p > .20
Medicine ball throw	8.93	6.10	11.00	1.25	-0.37	-0.19	0.25	p > .20
10 m running	1.83	1.72	2.00	0.08	0.75	-0.48	0.15	p > .20
20 m running	3.25	3.09	3.57	0.15	1.09	0.18	0.10	p > .20
30 m running	4.43	4.09	4.90	0.20	0.77	0.68	0.17	p > .20
Slalom test	7.23	6.70	8.02	0.35	0.60	0.37	0.20	p < ,15
Zigzag test	6.21	5.53	6.98	0.44	0.17	-0.97	0.18	p > .20
9-3-6-3-9 test	8.20	7.45	9.40	0.50	0.97	1.58	0.14	p > .20

Legend: AM – arithmetic mean, Min – Minimum result, Max- maximum result, SD - standard deviation, Skew – Skewness – measure of distribution shape, Kurt – Kurtosis – measure of distribution curve, MaxD – maximum distance between relative cumulative theoretical frequency (normal) and relative cumulative empirical frequency (obtained by measuring), K-S p – statistical significance of Kolmogorov-Smirnov test. Limit value of KS test for N=30 is 0.25.

Table 1 shows the results of descriptive statistical procedures on variables of morphological characteristics and motor abilities. Considering the fact that central and dispersive parameters are not the aim of this paper, they are showed since relevant sample of examinees was used – young soccer players, so they can be used in further comparisons of the result. As it can be seen from table 1, none of the values of KS test did not move beyond the limit value – all variables had distribution that did not significantly deviate from the normal value.

Table 2 shows the results of liner correlation analysis, which determined the relation of variables for evaluation of motor (on one side) and morphological characteristics (on other side). Out of 81 correlation coefficients, 19 were significant, indicating a relatively good relation in this set of variables.

Table 2. Correlation matrix

Variables	Long jump	High jump	Medicine ball throw	10m running	20m running	30m running	Slalom test	Zigzag test	9-3-6-3-9 test
Body height	0.72	0.56	0.92	-0.63	-0.55	-0.51	0.36	-0.04	-0.36
Body mass	0.73	0.49	0.94	-0.55	-0.57	-0.43	0.41	-0.09	-0.30
Knee diameter	0.38	0.39	0.36	-0.34	-0.16	-0.24	0.28	-0.21	-0.40
Elbow diameter	0.69	0.43	0.94	-0.47	-0.57	-0.38	0.42	-0.13	-0.22
Upper arm circumference	0.65	0.34	0.86	-0.47	-0.57	-0.39	0.42	-0.08	-0.20
Lower leg circumference	0.70	0.42	0.70	-0.29	-0.40	-0.27	0.02	-0.52	-0.31
Dorsal skinfold	0.64	0.27	0.68	-0.15	-0.33	-0.17	0.26	-0.45	0.05
Abdominal skinfold	0.32	-0.08	0.35	0.25	0.27	0.18	0.36	-0.10	0.43
Lower leg skinfold	0.57	0.10	0.41	-0.01	-0.09	-0.06	0.19	-0.38	0.27

It is interesting to single out 7 significant correlation coefficients (out of 9 possible), which relate the *Standing long jump* variable and 6 significant correlation coefficients that relate the *Medicine ball throw* variable with morphological variables. Primarily, this relation was defined by significant positive influence of all volume variables on these motor manifestations. Therefore, it can be ascertained that the examinees with higher voluminosity (including body height and mass, diameters and circumferences, even some skinfolds) achieved better results in these two tests.

Body height and *mass, Elbow diameter* and *Upper arm circumference* were significantly correlated with *20 m running*. *Body height* was significantly correlated with *High jump* and *10 m running* variables. The sign in front of the correlation coefficients should not confuse, since the variables were scaled in reverse. This indicates a fact that growth and development directly define the efficiency of these tests. This was confirmed in several past researches. Basically, the subject is suppression effect, since height and mass are directly correlated to biological maturity. Chronologically older examinees achieved better results in speed and explosive power, so it is logical that the correlation between height and mass (on one side) and speed and explosive power tests (on other side) was determined.

Between those two groups of variables no significant correlation was observed. It is possible to define that specific motor variables (soccer motor ability) were influenced by specific motor knowledge more than by morphological characteristics of the examinees.

The use of regression analysis showed that most correlation were not significant. In further text only significant regressions would be processed (Table 3).

From the predictor group perspective, the *Long jump* variable satisfactorily explained significance, with 58 % of explained variance. The highest global relation was observed in *Body height* and *Body mass* variables. Taller and lighter examinees achieved better results in this test. The reverse is obvious in the prediction of *Medicine ball* throw variable, and the highest global relation was noticeable again in *Body height* and *Body mass*, explaining 76% of criterion variance. This means that shorter and heavier examinees achieved better results in this test. The *10 m running* variable was explained by predictor group on the satisfactory level of significance, with 58% of explained variance. The highest global relation was observed in *Body mass, Body height* and *Upper arm circumference*. That is, shorter and lighter examinees with higher values of circumference achieved better results in this test (it can be assumed that examinees with higher circumference had more muscle). The predictor group explained *Slalom* variable on satisfactory level of significance, with very high 88% explained variance. The highest global connection is noticeable in the set of variables that describe voluminosity and subcutaneous adipose tissue. While the influence of non-adipose voluminosity was positive. The examinees with higher values of circumference and lower values of subcutaneous adipose tissue achieved better results in this test.

The remaining criterions were not significantly related with morphological predictors, what can be probably explained by previously mentioned influence of specific motor knowledge.

Table 3 Multiple regression analysis - significant regressions (R – multiple correlation coefficient; R^2 - determination coefficient; p – level of significance; BETA – beta ponder of predictor variable)

Criterion	Long jump		Medicine ball throw		10m running		Slalom test	
Variable	Beta	p-level	Beta	p-level	Beta	p-level	Beta	p-level
Body height	0.91	0.09	-0.50	0.32	0.92	0.02	0.62	0.54
Body mass	-0.46	0.61	0.84	0.27	0.84	0.05	0.46	0.51
Knee diameter	0.19	0.52	0.08	0.74	-0.51	0.37	0.69	0.05
Elbow diameter	0.16	0.57	0.39	0.11	-0.04	0.26	-0.23	0.09
Upper arm	0.28	0.47	0.12	0.70	-0.90	0.01	-0.39	0.69
Lower leg circumference	-0.18	0.63	-0.47	0.14	0.20	0.88	-0.84	0.00
Dorsal skinfold	-0.07	0.75	-0.08	0.67	0.11	0.20	0.87	0.01
Abdominal skinfold	0.11	0.60	-0.01	0.94	-0.03	0.38	0.02	0.94
Lower leg skinfold	-0.01	0.94	0.24	0.12	0.16	0.32	0.11	0.72
R	0.75		0.87		0.76		0.94	
R^2	0.58		0.76		0.58		0.88	
P	0.02		0.00		0.04		0.05	

CONCLUSION

The basic aim of this research was to determine the relation between morphological characteristics and motor abilities in young soccer players. The conducted analysis showed that morphological structure in lesser degree determined motor success in here analysed sample of examinees. This is explained by the fact that the examinees (early puberty age) did not reach the period of accelerated growth and development, so the differences in their morphological stature were not that pronounced to represent a significant factor in the perspective of motor abilities, in any direction. Besides this, it is very possible that specific motor knowledge significantly influenced the performance of certain tests, and regarding the fact that characteristic – specific motor abilities were included, this influence surpassed the influence of morphological characteristics. Further research should determine the relation between these anthropologic dimensions for older age groups of soccer players, where stronger influence of morphological characteristics on motor success should be expected.

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THE DIFFERENCES IN EMOTIONAL INTELLIGENCE OF INDIVIDUAL ATHLETES CONSIDERING THE TYPE OF THE SPORT AND THEIR PERFORMANCE

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SUMMARY

Numerous authors assume that emotional intelligence could be one of the determining factors for athletes engaging in certain sports, and that it may also have to do with sports performance. This paper deals with the differences in the intensity of emotional intelligence and its subfactors with athletes of different performance, who are engaged in judo, swimming and athletics. We have used the UEK-45 instrument (Takšić, 2000) and the results obtained show that judo players have more prominent emotional intelligence than swimmers and athletes, and that there are no statistically significant differences with more successful athletes (who have won medals in the senior national competitions) compared to less successful athletes (who don't have senior medals).

Keywords: emotional intelligence, individual athletes, performance

INTRODUCTION

A longer period of time has been required for the concept of emotional intelligence to obtain its final definition. The definition of emotional intelligence has been changing over time. Salovey and Mayer, who made the first hierarchical model of emotional intelligence (Salovey & Mayer, 1990), defined it primarily as the ability to monitor their own and others' emotions and to implement the information obtained by such monitoring in behavior and thinking. Such ability, according to this definition, includes: assessing and expressing their own and others' emotions, control of these emotions and their use in the adaptation. The same authors (Mayer & Salovey, 1999) complement the definition and suggest four capabilities that make emotional intelligence:

- the ability of rapid perception, assessment and expression of emotions,
- the ability to grasp and generate feelings that make opinion making easier,
- the ability to understand emotions and knowledge about emotions,
- the ability to regulate emotions in order to improve the emotional and intellectual development.

The biggest concern related to emotional intelligence is whether it is an ability or a personality trait. This dilemma primarily stems from the operationalization of the subject of measurement. The authors who are pleading for the observation of emotional intelligence as a line, operationalize it through self-assessment questionnaires (such as most personality tests) and they are also referring to it as a line of emotional self-efficacy (Petrides, 2011).

Takšić (1998, 2002) assumes a tri-factor structure of emotional intelligence (or emotional competence, as it is also called) consisting of the following factors: the ability to identify and understand emotions, the ability to express and name emotions and the ability to manage emotions. He also constructed three questionnaires in which respondents evaluate the presence of these factors in themselves: UEK-136, UEK-45 and UEK-15, of which UEK-45 has proven to be the one with best performance and the one most used (Takšić, 2002).

Athletes who have more prominent emotional intelligence often use psychological skills and techniques in training and in competition (Lane, Thelwell, Lowther & Devonport, 2009). With runners on extremely long runs (282 km) there are frequent mood changes during the race and it was shown that those runners who have more prominent emotional intelligence are significantly more likely to experience pleasant emotions than unpleasant ones and authors (Lane & Wilson, 2011) assume that expressed emotional intelligence is the main reason why some athletes are often better able to withstand strenuous exercise than others. Some studies (Laborde, Brüll, Weber & Anders, 2011) indicate that athletes with prominent emotional intelligence experience smaller increase of stress (measured by the increase in heart rate) in the same situations, compared to those with less prominent line of emotional intelligence.

By doing a research on six cricket teams of elite level in South Africa, during two seasons, Crombie and his associates (Crombie, Lombard, & Noakes, 2009) found a relationship between the average emotional intelligence of all the players in the team and their success in the competition and concluded that the high score of emotional intelligence is an important comparative advantage in sports. Perlini and Harvelson (2006) have been determining the relationship between the emotional intelligence, on the one hand, and the number of goals scored and the number of games played in the National Hockey League (NHL - one of the most elite league competition in the world of sports in general) on the other hand, and showed a positive relationship between these parameters. Mitić and his associates (Mitić, Mitrović, Bratić & Nurkić, 2011), found statistically significant difference between a controlled sample of amateur judo players when comparing them in terms of their scores expressiveness on the overall emotional competence scale and the emotion management subscale. Students of the Faculty of Sport and Physical Education, who are engaged in or prefer martial arts and gymnastics, have more prominent overall emotional intelligence and are better at managing their emotions (Todorović, Marković, Mitić, Mitrović, 2013). The ability to express emotions and appoint them is stronger with SportHigh School students compared to students of "normal" High Schools (Takšić, 2005).

In this paper we wanted to verify whether the expression of emotional competence and its subscales are associated with being engaged in certain individual sport and whether more successful athletes differ from less successful ones in the expression of emotional competence.

METHODS

The sample is consisted of 77 athletes (32 judo players, 23 athletics and 22 swimmers)The study includes a questionnaire of emotional competence (UEK-45) (Takšić, 2000) which is a shortened version of the UEK-136 questionnaire and consists of 45 claims in which the respondent answers by circling one of the numbers offered in a five-point Likert scale. The answers represent the subject's assessment of the development of their abilities related to emotional competence. In addition to the total score, there are the problem of identifying and understanding emotions, the ability of expressing and naming emotions and the ability to manage emotions scores on subscales.

Statistical analyses

The statistical Package for Social Sciences SPSS (v17.0, SPSS Inc., Chicago, IL) was used for the statistical analysis. Descriptive statistics was calculated for all variables. One-way univariate analysis of variance (ANOVA) was used to assess differences between judo, athletics and swimmers participants in all the variables. When a significant Fvalue was achieved, appropriate *post hoc* tests procedures were used to locate the difference between the means. Statistical significance was set at $p< .05$.

RESULTS

Through this research it is checked whether there are differences in the expression of overall emotional competence between athletes who are engaged in judo, swimming and athletics. In addition, it is checked whether there are differences in the expression of certain aspects of emotional competencies such as the ability to recognize and to observe the emotions of others, the ability of naming and expressing emotions and the ability to control and regulate emotions.

Results shown through Table 1 indicate that there are statistically significant differences ($p <0.05$) in the expression of aspects of emotional competence and in expressing and naming emotions among athletes of different sports. When reviewing Table 2, where the average values of different aspects of emotional competence, depending on the sports played, is expressed it can be seen that the highest score of the aspect of emotional competence, Expressing and naming emotions ($M = 52.96$) is achieved by athletes who are engaged in judo, compared to the other athletes. Besides, it is shown that there are statistically significant differences ($p <0.05$) in the total expression of emotional competence among athletes of different sports. In fact, athletes who are engaged in judo have the most prominent overall emotional competence ($M = 172.93$), while the athletes who are competitive swimmers have the least prominent one (M = 163.90).

Table 1. Variance analysis - The differences in expression of emotional competence (total score) and its certain aspects

		Sum of Squares	Df	Mean Square	F	Sig.
Recognize and observe the emotions	Between Groups	47.909	2	23.955	.480	.621
	Within Groups	3690.948	74	49.878		
	Total	3738.857	76			
Naming and expressing emotions	Between Groups	468.091	2	234.046	4.094	.021
	Within Groups	4173.014	73	57.165		
	Total	4641.105	75			
Manage emotions	Between Groups	146.442	2	73.221	1.979	.146
	Within Groups	2700.558	73	36.994		
	Total	2847.000	75			
Emotional competence – overall	Between Groups	1468.021	2	734.011	3.109	.047
	Within Groups	18814.326	72	261.310		
	Total	20282.347	74			

Table 2. The average scores on scales of emotional competence with athletes who are engaged in judo, swimming and athletics

Sport	Recognize and observe the emotions	Naming and expressing emotions	Manage emotions	Emotional competence – overall
Judo	55.9063	52.9687	64.7419	172.9355
Swimming	54.1818	47.4545	61.4091	163.0455
Athletics	55.9565	52.8636	63.8261	172.5000
Total	55.4286	51.3421	63.5000	169.9067

Through the process of variance analysis and by using post hoc tests (Tables 3 and 4), it was verified among which particular groups of athletes there are the most prominent differences in emotional competence. Survey results (Table 3) show that the differences are statistically significant in terms of expressing the aspects of emotional competence Expressing and naming emotions, and that athletes who are engaged in judo have more prominent aspect of emotional competence, which is mentioned, in relation to athletes who are competitive swimmers ($p < 0.05$). It has been shown that athletes who are engaged in athletics have more prominent aspect of emotional competence Expressing and naming emotions, compared to athletes who are competitive swimmers, and that this difference is statistically significant ($p < 0.05$).

Table 3. Post hoc tests - the differences in the expression of emotional competence (total score)

Dependent Variable	(I) Type of sport	(J) Type of sport	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Naming and expressing emotions	Judo	Swimming	5.51420*	2.09399	**.010**	1.3409	9.6875
		Athletics	.10511	2.09399	.960	-4.0682	4.2784
	Swimming	Judo	-5.51420*	2.09399	**.010**	-9.6875	-1.3409
		Athletics	-5.40909*	2.27964	**.020**	-9.9524	-.8658
	Athletics	Judo	-.10511	2.09399	.960	-4.2784	4.0682
		Swimming	5.40909*	2.27964	**.020**	.8658	9.9524

These results indicate (Table 4) that there are statistically significant differences ($p < 0.05$) in the total of emotional expression competences between athletes who are engaged in judo and swimming, and that those athletes who are engaged in judo have more prominent emotional competence.

Table 4. Post hoc tests - the differences in expression of aspects of emotional competence related to the appointing and expressing emotions

Dependent Variable	(I) Type of sport	(J) Type of sport	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Emotional competence – overall	Judo	Swimming	9.89003*	4.50634	**.031**	.9068	18.8733
		Athletics	.43548	4.50634	.923	-8.5477	9.4187
	Swimming	Judo	-9.89003*	4.50634	**.031**	-18.8733	-.9068
		Athletics	-9.45455	4.87396	.056	-19.1706	.2615
	Athletics	Judo	-.43548	4.50634	.923	-9.4187	8.5477
		Swimming	9.45455	4.87396	.056	-.2615	19.1706

It has also been verified whether there are differences in the expression of emotional competence and its aspects, depending on whether athletes are winning medals (Tables 7 and 8), so it has been found that there is no statistically significant difference in this respect.

Table 7. The average values of expression of emotional competence with athletes depending on whether they have won medals

Medal	Recognize and observe the emotions	Naming and expressing emotions	Manage emotions	Emotional competence – overall
yes	55.5526	52.1579	64.0000	171.7105
no	55.3077	50.5263	63.0000	168.0541
Total	55.4286	51.3421	63.5000	169.9067

Table 8. Variance analysis - the differences in the expression of emotional competence with athletes depending on whether they have won medals

			Sum of Squares	df	Mean Square	F	Sig.
Recognize and observe the emotions	Between Groups	(Combined)	1.155	1	1.155	.023	.879
	Within Groups		3737.702	75	49.836		
	Total		3738.857	76			
Naming and expressing emotions	Between Groups	(Combined)	50.579	1	50.579	.815	.369
	Within Groups		4590.526	74	62.034		
	Total		4641.105	75			
Manage emotions	Between Groups	(Combined)	19.000	1	19.000	.497	.483
	Within Groups		2828.000	74	38.216		
	Total		2847.000	75			
Emotional competence – overall	Between Groups	(Combined)	250.639	1	250.639	.913	.342
	Within Groups		20031.708	73	274.407		
	Total		20282.347	74			

DISCUSSION AND CONCLUSION

The results of the pronounced emotional intelligence are in agreement with previous results of Mitic and associates (Mitic, Mitrovic, Cousin & Nurkić, 2011), in which judoists were compared with a control sample and they found no statistically significant difference between them in terms of scores on a scale overall emotional competence and subscale manage emotions. Also, this result is consistent with the work of Todorovic et al (Todorovic, Markovic, Mitic, Mitrovic, 2013) which shown that the students of the Faculty of Sport and Physical Education who dealing with or prefer martial arts and gymnastics have higer score of emotional intelligence and better manage emotions. A possible explanation of differences in the emotional intelligence in judo players in relation to the swimmers and athletics could be found in the nature and requirements of the aforementioned sports. Unlike swimming and athletics, judo is a contact sport and it belongs to the so-called open motor skills in which performance and success does not depend on only one competitor and its performance, but also of the reactions and performing of opponents. Such requirements of the judo require better manage emotions,

On the otherhand, the results of this study suggest that there is no difference in the emotional intelligence in a more or less successful athletes (those who won and those who did not win the medal). These results are in contrast with the findings of some studies (Crombie, Lombard,&Noakes, 2009, Perlini and Harvelson, 2006) in which the higher emotional intelligence was associated with success in sport. It should be mentioned that these studies were conducted with the collective athletes.

At the end, it can be concluded that athletes who train different individual sports vary in emotional intelligence and judo had a significantly more pronounced emotional intelligence in relation to swimmers and athletes, and that there is no statistically significant difference in the emotional intelligence among athletes of different performance success.

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QUALITATIVE ANALYSIS OF COUNTER ATTACK IN FOOTBLALL – THE FINAL OF THE CHAMPIONS LEAGUE 2014/2015

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SUMMARY

This paper is aimed at analysing counter attack deployment and its structure within successfully performed moves in the final of the Champions League club competition in 2014/2015. The research objective was to try to determine the extent to which and the way in which the teams use counter attack as their tactical choice during the most important matches of the season. The exploiting by the following four teams Barcelona, Juventus, Real Madrid and Bayern Munich was analysed in four semi-finals and in the final match of the said competition. The observation included the overall number of successful attacks of each of the team and a counter attack was defined as an attack started from: defence zone that lasted 8 minutes most; middle zone that lasted 6 seconds most or the one that started form the attack zone and lasted 4 seconds most. The counter attack zone was assessed according to its initiation zone, way of getting a ball in possession, number of players participating in it and number of passes; type of final pass and the distance from which a shot was taken. The obtained results indicate that every fourth shot resulted from a counter attack, which is mostly initiated in the middle zone. This type of attack starts by taking over or intercepting the ball, followed by a deep pass and a square back pass and in most cases ends in shooting form 16-meter line.

Keywords: Football, Attack Tactics, Counter attack

INTRODUCTION

The preparation of football players for achievement of top results includes: technical, tactical, physical, psychological and educational preparation. Each of the stated components of football education has its own regularities and is an indispensable factor of the comprehensive, integral preparation for football players. The subject of this paper belongs to tactic preparation or more specifically to attack tactics within which we can differentiate, according to the performance speed, position and fast or counter attacks, which together with organization of offensive break make the attacking tactical plan of the game of a team. The game of football, through its evolution, has passed certain development periods dominated by a certain preparation type. However, recently, two directions in tactical options have been defined: direct and creative football. Direct football is featured by quick game in transition aimed at jeopardising as soon as possible the opponent's goal while creative football includes creating moves through greater number of passes of the ball with significantly more ball possessions than the opponent. Both options in the attacking tactics were represented by those who achieved top results. However, based on recent analysis of competitive activities, it can be concluded that the teams that use in their game elements of both direct and creative i.e. the teams that apply quick attacks in each situation that allows it but also position attacks in those situations when counter attack is not an option.

Research that deals with the issues of football tactics indicate that the duration of successfully performed attacks at big world competition, in 60% of the cases is up to 8 seconds (Janković et al., 2009; Luhtanen et al., 2001), the number of players engaged in successful attacks in 80 % of moves was 4 players most and according to some authors (Vasilis et al., 2005) even in 70% was 3 or less players. These data undoubtedly confirm that increasing attention in the coaching process is devoted to the moment of change of ball possession, with a try to use a non-formed or deformed last defence line of the opponent. This style of the game has all the features of a counter attack as a type of attack in the game of football but is also featured by quick and unexpected performance, with participation of only few players (two to three), occasionally even of one player only (Toplak, 1989). In order to have an efficient counter attack, it is essential that its participants have high level of visual and special spatial orientation, top technique and high level of physical preparedness. (Aleksić & Janković, 2006*).* The research aimed at identifying differences between successful and unsuccessful teams, concluded that higher percentage of counter attack correlates with positive result (Janković et al., 2011a, 2011c; Lago et al., 2010). Counter attack as a type of attack in competitive match is equally manifested in play of both European and South American teams, so that, in the course of one match, an average of 4.5 successful offensive moves of one team has features of counter attack (Janković A., & Leontijević B., 2007). All the results so far are based on longitudinal studies that encompassed great number of matches of high importance. However, it would be interesting to see how often and what kind of counter attack was applied in individual high-priority matches such as finals of the highest quality competition. Thus, this research is aimed at determining the volume and structure of counter attack in highest-priority matches at this moment.

METHODS

Subjects

The observation protocol was used to analyse the manifestation of the highest-placed football teams in the finals of the 2014/2015 Champions League, the overall of four teams – two Spanish (Barcelona, Real Madrid), one Italian team (Juventus) as well as a German team (Bayern Munich). The total of five matches was analysed, four semi-finals and the final match.

Procedure

The analysis of the previously recorded all of the five games was approached by formation of the observation protocol (Carling et al, 2005). That sheet was used for each individual match. Video materials were taken over form the channels of Serbian Broadcasting Company and EUROSPORT. Each successful attack was individually recorded by notation system in a previously formed observation sheet.

The variables for this observation were chosen as primary for the subject of the analysis and resulted from basic theoretical and practical notions and principles, the game of football and its evolution. An overall number of successful attacks of all teams separately at each match were involved. All successful attacks were classified as: position, counter attacks and set-pieces attacks. A counter attack was defined as an attack started from: defence zone that lasted 8 minutes most; middle zone that lasted 6 seconds most or the one that started form the attack zone and lasted 4 seconds most. Position attack included each successful attack not classified as counter attack by duration. The counter attack structure was assessed based on: part of the pitch at which it was initiated (defence, middle or attack zone), way of getting a ball possession (taking over, interception, from the goalkeeper, gained second ball after the stoppage time without a direct shooting at the opponent's goal), type of final pass – assists (deep pass, back ball, straight shot, second ball or individual final shot) and distance from which it was shot (16 >, 11-16, 5-11, <11).

Statistical analysis

For quantifying the relations between the variables, we have applied the statistical method and descriptive statistics was the first aspect of the quantitative analysis. The following statistic descriptive areas were determined: distribution of frequency for each variable expressed in the form of interval statistical series i.e., nominal statistical series. Arithmetic mean was used from the segment of measures of central tendency and of dispersion measures, the most frequently used was standard deviation.

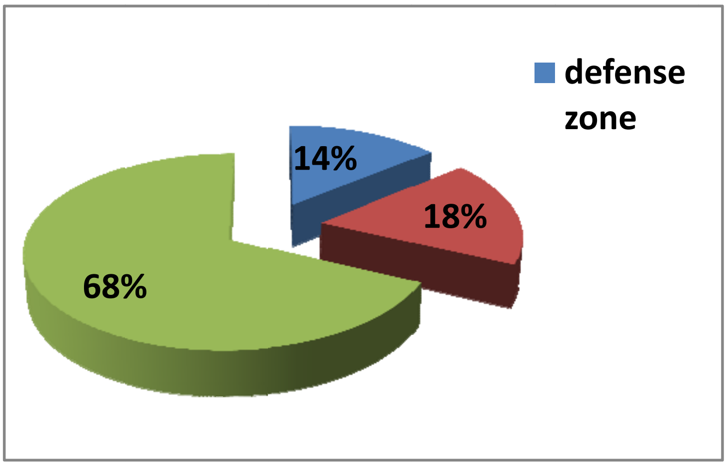
RESULTS AND DISCUSSION

The results obtained by this research indicate that, of the overall number of successful attacks, shooting at goal most often resulted after position attacks (≈ 60%), followed by counter attacks (25%) and only 16% were set-pieces attacks (Table 1.). Such distribution of different types of attacks in the final matches of the Champions League showed that the matches with overemphasized competitive aspect are specific and tactically different from other matches. These data indicate that teams are cautious at the beginning of attacks when a reduced number of lost balls on its own half result in reduced opponent's possibility to realize a counter attack. Additionally, the play "behind the ball" on the opponent's half is an important segment of tactical game plan, which also influences the possibility to realize opponent's fast attack. On the other hand, every third scoring was accomplished after a counter attack, which proves the efficiency of this type of attack, but also the importance of the match and opponent's quality, which impeded greater use of quick attacks. For example, the Champions League winner (Barcelona) had the highest percentage of realized but also efficient counter attack. The results indicate that stoppage of the game did not significantly affect the results and team effectiveness. The research dealing with standard situation prior to stoppage in the game indicate that even 30-40 % of scoring was achieved in this way (Janković et al., 2011d). Therefore, it is obvious that usage and efficiency of position attack significantly affected the results in such important matches.

Table 1. Application and accuracy of certain types of attack finished in shooting at opponent's goal

	Attacks	*Position attacks*	*Counter attacks*	*Set pieces attacks*
Sum	111	65	28	18
Average	11,1	6,5	2,8	1,8
%	100	59	25	16
On target	40	22	12	6
Wide	54	34	10	10
Goals	17	9	6	2

The structure of realized counter attacks was analysed with regard to the zone in which they were initiated. The Chart 1 shows that this type of attack usually started in the middle zone i.e. somewhere in the middle of the pitch. Such data indicate that an organized beginning of a team attack, which reduces opponent's possibility to use pressing and thus reduces the number of lost balls in this phase of match. On the other hand, counter attack from the middle zone is realized against a small number of players in big area simultaneously increases the possibility to score a goal from this type of attack. This way, it is possible to attack the opponent's defence by deep passing, behind of the opponent's centre backs, which usually provides in this situation a certain advantage to fast attacking players. The research of the matches of the domestic Serbian Championship showed that attack zone is dominant part of the pitch to initiate successfully performed counter attacks (Leontijević & Obrenović, 2013). By comparison, of these two competitions it can be concluded that organization of the attack beginning is essential factor in determining the total use of realized counter attacks, as well as that the quality of zone defence in the middle field is an essential prerequisite for a quality counter attack. Based on that it can be stated that the moment of change in possession that occurs in the middle zone is essential for realization of counter attack, on one side by rapid and energetic moves that will prevent the opponent's attack after the ball has been lost and on the other side by attacking swiftly the opponent's unsettled defence situation with the open space behind their backs. The greatest number of initiated counter attacks in semi-finals of the Champions League 2014/2015, were realized from the defence zone by the players of *Barcelona* (4), from the middle zone by the players of *Juventus* (6), while all four teams realized one successful counter attack each from the defence zone.



Graph 1. Zones of initiated counter attack

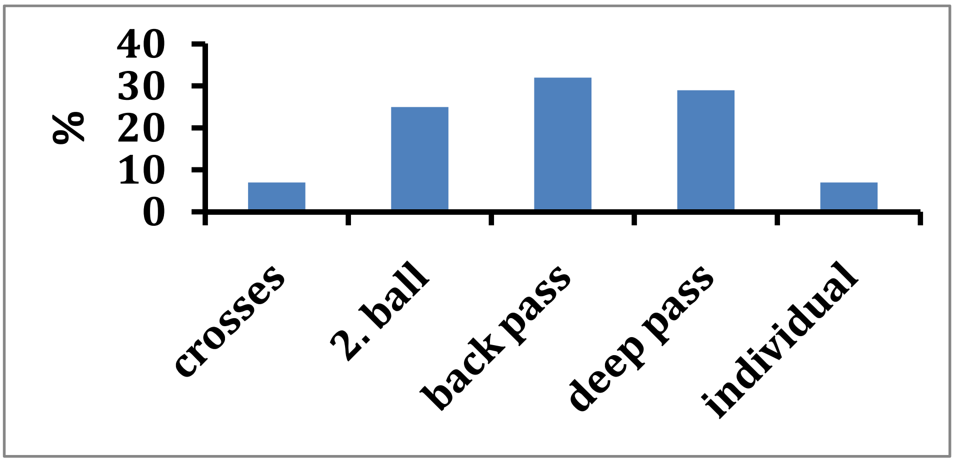
It was ascertained that middle zone is the area by far most used for realization of counter attacks in the final matches of the Championship league. The next information that shows the structure of this type of attacks, and therefore the tactical option in this phase of the game, at the high-priority matches is the way in which such attacks were initiated. Table 2 displays that the highest number of counter attacks were initiated after tackling and slightly less after the 2nd ball gained on this part of the pitch. The tackled ball in the middle zone in direct play one-on-one at the same time provides an excess of players for the team in possession of the ball, and therefore a quick attack with one player more is the first option at that moment. Winning of the so-called second balls mostly imply greater total number of attacks of a team or in this case greater number of counter attacks. Additionally, winning of the second ball implies that the opponent's defence is still unsettled and not aligned providing thus an increased opportunity to realize a quick attack. Table 2 also displays that only two counter attacks were realized after the moves initiated by the goalkeeper, which indicates a good defensive transition after losing the ball, mostly after the midfield shots from side positions, where a counter attack is tried after goalkeeper has caught the ball.

Table 2. Way of initiating, average number of passes and number of players participating in realization of successful attacks

Starting attacks	*Attacks*	*Position attacks*	*Counter attacks*
Goalkeeper	8	6	2
Tackling	27	19	8
Interception	22	12	10
2. ball	21	17	4
Set-pieces game	15	11	4
Num. players (average)	3,43	4,26	2,46
Num. passes (average)	3,68	5,14	1,89

The results of this study showed that the average number of players participating in successful attacks is from 3 to 4, the same as the number of passes. Such data were obtained even in the sample of the high quality national team competitions (Janković et al., 2011b). When it comes to counter attacks, we can see that they are mostly realized by 2 or 3 players with an average of two passes in the realization phase.

The next index of the way of counter attack is performed is the way of executing the final pass or assists. Graph 2 shows that back passes and deep passes most frequently preceded shooting at goal in the realized counter attacks. Such data result from the fact that the greatest number of counter attacks was initiated in the middle zone where the last opponent's line was attacked either by direct deep pass or by one square deep pass, by back pass a player was engaged for the final moves of the attack. Direct deep pass or square pass, when changing possession of the ball, prevents the opponent to use pressing and get in possession of the ball and most important enables rapid transition to the closing phase of an attack- Additionally, the greatest number of shots at goal of this type of attacks was performed from the area around the 16-meter line, which is actually the consequence of the assists by back passes but also by deep passes, with the opponent's goalkeepers standing slightly closer to the last defence line in such situations and the strikers finish the attack by fast ground shooting from the distance.



Graph 2. The way of final pass (assist) performance in counter attack performance

CONCLUSION

Counter attack is a typical situation in the game of football and can be performed in every moment provided that certain conditions are attained, such as opponent's mistake due to the pressing game and it can be carried out on any part of the pitch, although football practice showed that it is most efficient when used closer to the opponent's goal. By observing counter attack, its structure, model and specificities, it can be perceived that there are differences in defence organization, depending on the starting zone and even on the development of counter attack itself. The differences in choosing the means and performance of counter attacks, are reflected in technical-tactical abilities of the individuals and the team as a whole as well as of the opposing teams. The teams with more trained and more coordinated individuals, complete the counter attacks with less players, passes and drillings, and with more manifested pressing game closer to the opponent's goal. With the teams with lower level of technical-tactical preparedness, counter attacks are more result of unplanned i.e. accidental game situations. The tendency of intensification of both defensive and offensive activities has been noticed in the game of football. There is a stressed wish to complete actions in shortest possible interval, with as few as possible ball touching and players involved.

This research showed that deployment and even structure of counter attacks is different in particular highest-priority matches compared to league competitions. The final of the Championship League was not recognizable by rapid and efficient attacks but more by position and patient offensive actions. Namely, the teams managed to finish every fourth successful attack by counter attach, starting it most often from the middle zone, by getting the ball in possession through tackling and winning of the so called long balls, attacking directly deep and side areas of the pitch, and completing the actions by kicks from the area bordering penalty area. Such results can be explained by the importance and significance of the observed matches. The teams reduced the risk of lost balls in the initial phase of the attack and stressed the moment of change of the ball possession and by patient position attacks came to the position to jeopardize the opponent's goal.

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THE USE OF THERMOVISION CAMERA IN SPORT

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SUMMARY

The objective of this work is to present the possibility of using thermovision camera in sport and to present the advantages and disadvantages which those who are using this modern diagnostic procedure face every day. This research is an applied experimental research type. The examinee was a sub-elite football player with an ACL injury. He was diagnosed with the total ACL rupture of the left leg, cured by means of a surgical procedure after which the examinee started with a specific physical preparation and rehabilitation program Thermographic recording of the examinee was performed by means of the thermovision camera type E30 (FLIR Systems, Sweden) with thermic sensibility of less than 0,1°C, accuracy ±2% from the registered temperature and photo resolution of 160 × 120 pixels. Thermographic photos obtained with the FLIR E30 camera were analyzed with the help of FLIR Tools software package. The temperature of 3 regions of the front side (thigh, knee, lower leg) and 4 regions of the back side (thigh, knee, lower leg, upper part of the lower leg-calf) was monitored. The results of the presented research show the significant difference of the temperature in the knee region in the initial measuring, and significant decreasing of asymmetry after four weeks of specific physical conditioning.

Keywords: sports injury, ACL, football, infrared thermovision

INTRODUCTION

Due to the accelerated development of technology in the last decade, diagnostic procedures in sport and physical education became far more precise, simple, efficient and less demanding for both the examiner and the examinee. Such a rapid development of new technologies made it possible for us to understand complex physiological reactions during an increased physical load but also to use new technical and technological recourses so as to improve, not only sports training, but also the recovery process of an athlete.

The recording process with the thermovision camera is one of those modern diagnostics methods which became widely available to a larger number of users due to this accelerated development. This is a non-invasive diagnostics method which doesn't even require any contact with the examinee except the visual one (Fernández-Cuevasa et al., 2015). Probably the most important advantage of this method is that the diagnostics is carried out without any radiation of the examinees whatsoever. With this method, the heat that the body emits through its surface is measured, where the temperature radiation is detected by means of recording the waves from the infrared magnetic spectrum (Čoh & Širok, 2007).

Thermovision camera recording started being used in medicine during the early '60s of the 20th century (Ammer, 2008) in breast cancer diagnostics, neurological disorders, (Ishigaki, Ikeda, Asai, & Sakuma, 1989), rheumatic processes, urological problems (Ng, Eng, Ng, & Tan, 2009), trauma and soft tissue diagnostics, inflammation processes of tissues which are in contact with implants and also in blood circulation of the extremities (Čoh & Širok, 2007). It is a well known fact that inflammation processes lead to local hyperthermia, whereas the degenerative processes related with the reduced muscle activity and poor circulation lead to hypothermia (Garagiola & Giani, 1990). Variations in the temperature of the body surface that represent some kind of heterothermic shield which contains homothermic nucleus can be caused by endogenous and exogenous changes. The temperature of the surface of the body depends on the function and the temperature of the internal organs, as well as on the heat characteristics of the tissue which separates these internal organs from the surface of the body, on the structure of the muscle and fatty tissue, on the blood circulation, on the skin moisture and the amount of energy produced by the homeostatic regulation of the metabolic processes (Žuber & Jung, 1997). Reduced temperature on the surface of the body often indicates musculoskeletal disorder and the low temperature of the skin around the injured joint is considered to be a strong indicator of a long recovery process (Eliyahu, 1992). The modern technology of infrared recording can give us valuable information regarding the functional treating of sports injuries. It is a well known fact that the trainings and competitions of the top athletes push the musculoskeletal system to the limits of anatomical and physiological capacities of the human body, which is why the number of sports injuries is constantly increasing (Kemper et al., 2015, Alentorn-Geli et al., 2009). These injuries mostly require a very long and very expensive rehabilitation period which is why each and every new method that could improve the rehabilitation process is of crucial importance for further development of sport.

Many academic and professional organizations promote the use of thermovision cameras as very effective and economical diagnostic methods in medicine in general, and even more so in sports medicine (Hilderbrandt, Raschner, & Ammer, 2010). Since 1987, several such organizations have been founded: American Academy of Medical Infrared Imaging, European Association of Thermology, United Kingdom Thermography Association, The Northern Norwegian Centre for Medical Thermography, The American Academy of Thermology and The German Society of Thermography and Regulation Medicine (DGTR) (Hilderbrandt, Raschner, & Ammer, 2010). All of them work on promoting the use of the thermovision method and the standardization of the protocol in clinical practice.

Although the infrared thermovision method is widely used in medicine, there is still not enough research out there which deals with the use of thermovision cameras in sport. The objective of this work is to present the possibility of using thermovision camera in sport and to present the advantages and disadvantages which those who are using this modern diagnostic procedure face every day. This research is an applied experimental research type.

METHODS

Subjects

The examinee was a sub-elite football player with an ACL injury. He was diagnosed with the total ACL rupture of the left leg, cured by means of a surgical procedure after which the examinee started with a specific physical preparation and rehabilitation program with the aim of bringing the examinee back to the condition he found himself in before the injury. Except for the ACL injury, the examinee had no other health problems. The examinee was informed about the measurement procedure and the objective of the research, both in person and in writing, after which he voluntarily joined the research signing the agreement in accordance with the ethical principles of the Helsinki declaration.

Procedure

The recording and the measuring related with the examinee were carried out during the months of August and September of 2015. All the measuring was performed in the premises of the SC "Čair" in the afternoons in a well illuminated-25m2 room. The examinee had only the necessary clothes on him. Before the actual measuring, the measuring of the basic anthropometric characteristics (BH, BM, BMI, %BF, Muscle Mass, and Visceral fat) was performed with the use of a thermovision camera. The measuring of the stated anthropometric parameters was carried out by means of an anthropometer, electronic scale Omron BF 511 (Omron Healthcare Co, Kyoto, Japan) and by means of the biometric impendence method. Before the measuring, the data regarding the body height, the age and the sex of the examinee were entered by means of a numeric keyboard.

Thermographic recording of the examinee was performed by means of the thermovision camera type E30 (FLIR Systems, Sweden) with thermic sensibility of less than 0,1°C, accuracy ±2% from the registered temperature and photo resolution of 160 × 120 pixels. The distance between the examinee and the camera was set at 2m, and the emissivity at ε =0,98, and there was white background of 1,0x2,0m behind the examinee so as to eliminate the influence of the reflexion of the background on the measuring. The room was 25m2 big and its temperature was of 24°C±1,5°C; the temperature was taken with a manual thermometer type ODT 0302 (Iskra, Slovenia), sensitivity ± 0,1 °C, accuracy ±0,05 °C.

The examinee was asked not to engage in exhausting, high-intensity physical activities 24h before the measuring, as well as not to take any alcoholic and caffeine drinks or use creams and tonics which could affect the moisture of the skin. Front and back thermograms were made for the lower extremities, whereas the examinee with only the necessary clothes on him was in the upright standing position.

Statistical analysis (Software and data analysis)

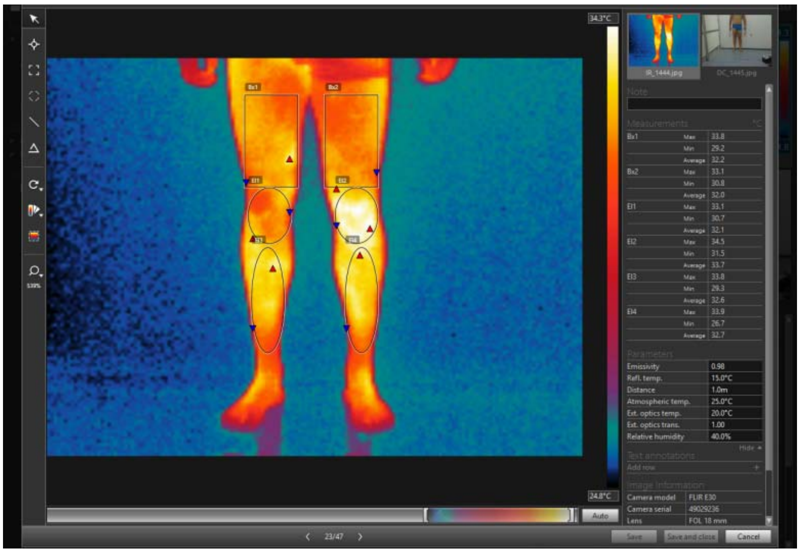
Thermographic photos obtained with the FLIR E30 camera were analyzed with the help of FLIR Tools software package. The temperature of 3 regions of the front side (thigh, knee, lower leg) and 4 regions of the back side (thigh, knee, lower leg, upper part of the lower leg-calf) was monitored. Maximum, minimum and average temperature for each region is determined. After that, the quantitative differences between the left and the right side of the regions were determined too.

RESULTS

The parameters of descriptive statistics of anthropometric characteristics for the examinee U.M at the initial and the final measuring are presented in Table 1.

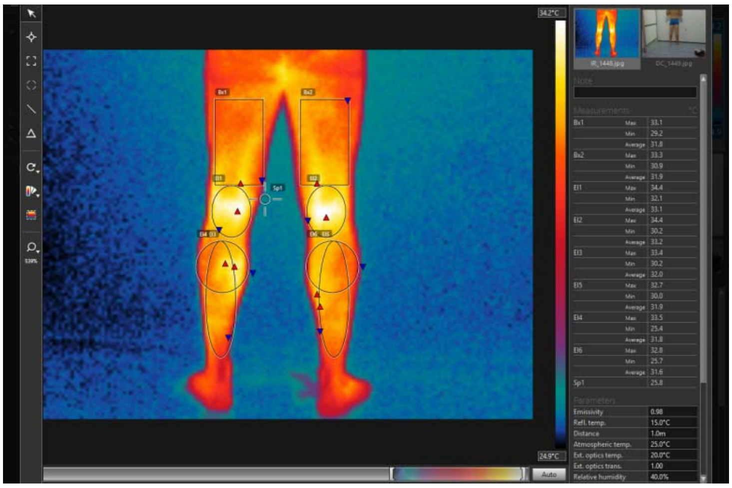
Table 1. Descriptive parameters of anthropometric characteristics

Parameter	Initial U.M.	Final U.M.
Age	18	18
Body height (cm)	180,0	180
Body mass (kg)	76,6	76,9
BMI	23,6	23,7
%Body fat	18,5	18,1
%Visceral fat	5	5
Muscle mass (kg)	41,4	42



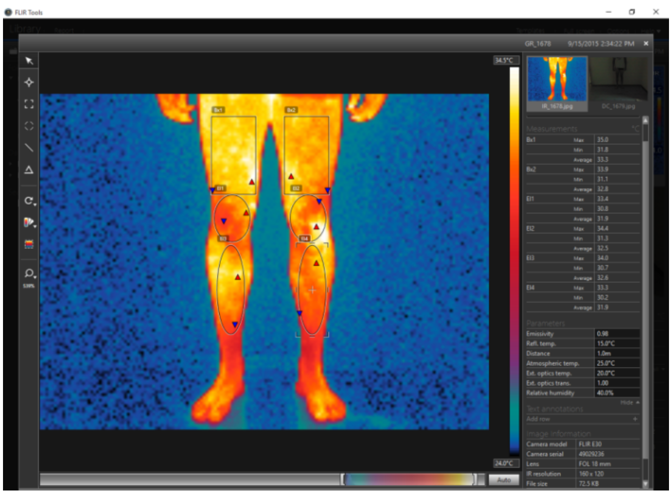
Picture 1. Thermogram of the examinee U.M. at the initial measuring (front side)

Pictures 1 and 2 represent thermograms from the initial measuring as well as the results of their analysis. The first thermogram shows visual asymmetry of the left and right knee. The obtained maximum temperature of the left (injured) knee is 34,5 ˚C, the average temperature is 33,7˚C, whereas the maximum temperature of the right knee is 33,1˚C, and the average is 32,1˚C. The difference between the maximum and average temperature of the left and right knee is 1,4˚C, that is 1,6˚C respectively. If we observe the temperature of the chosen surfaces of the left and the right thigh we can see that there is no difference in the average temperature (32,2˚C right thigh and 32,0˚C left thigh). As far as the lower part of the leg is concerned, there is also no significant difference in the average temperature (32,6˚C right thigh and 32,7˚C left thigh).



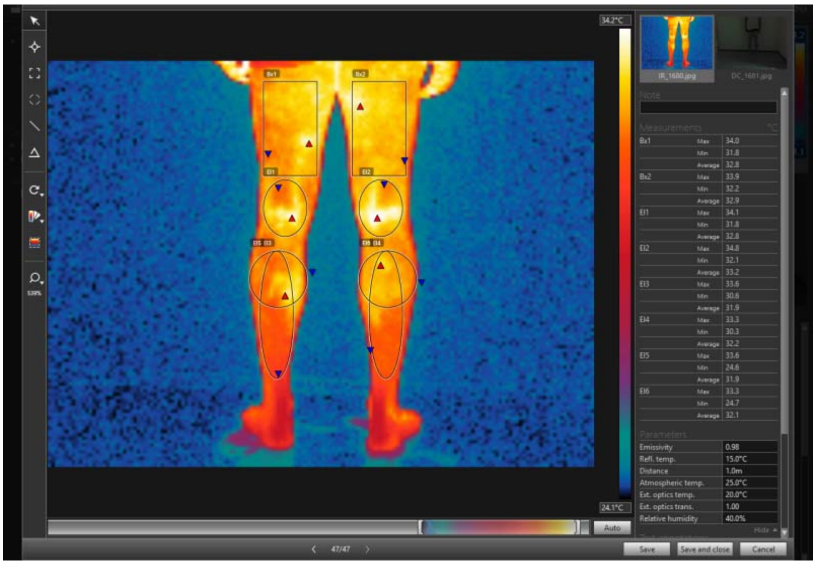
Picture 2. Thermogram of the examinee U.M. at the initial measuring (back side)

On the other thermogram, which shows the back side of the lower extremities, we cannot see visual asymmetry between the left and the right kneepit. Eight representative regions have been chosen and their temperatures have been analyzed. The obtained maximum temperature of both left and right kneepit was 34,4˚C, whereas the average temperature of the left kneepit was 33,1˚C, and the average temperature of the right one is 33,2˚C. The difference between the average temperatures of the left and the right kneepit is 0,1˚C. As far as the chosen kneepit regions of the back side are concerned, there was also no significant difference. The average temperature of the left kneepit was 32,0˚C and 31,9˚C of the right one. The upper regions of the back side of the kneepit had very little difference of 0,2˚C (31,8˚C the left one and 31,6˚C the right one)



Picture 3. Thermogram of the examinee U.M. at the final measuring (front side)

The thermogram presented in picture 3 shows the examinee U.M. at the final measuring, after four weeks of a specific physical preparation and rehabilitation program. The visual asymmetry of the left and right knee is far smaller than it was at the initial measuring. The obtained maximum temperature of the left (injured) knee was 34,4˚C, the average temperature was 32,5˚C, whereas the maximum temperature of the right knee was 33,4˚C, and the average one was 31,9˚C. The difference between the maximum and average temperatures of the left and the right knee was 1,0˚C that is 0,6˚C respectively. When observing the temperature of the chosen regions of the left and right thigh, we can see that there is a slightly larger difference in the average temperature now than there was at the initial measuring (33,3˚C right thigh and 32,8˚C left thigh). When it comes to the lower legs, there is also somewhat larger difference between the average temperatures of the chosen regions of the left and the right leg than there was at the initial measuring (32,6˚C right lower leg, 31,9˚C left lower leg).



Picture 4. Thermogram of the examinee U.M. at the final measuring (back side)

On the fourth thermogram, which shows the back side of the lower extremities at the final measuring, we can see a slight visual asymmetry of the left and the right kneepit. Eight representative regions have been chosen and their temperatures have been analyzed. The obtained average temperature of the left kneepit was 32,8, whereas the average temperature of the right kneepit was 33,2˚C. The difference between the average temperatures of the left and the right kneepit is 0,5˚C. As far as the chosen kneepit regions of the back side are concerned, there was also no significant difference. The average temperature of the left kneepit was 31,9˚C and 32,2˚C of the right one. The upper regions of the back side of the kneepit had very little difference of 0,2˚C (31,9˚C the left one and 32,1˚C the right one)

Table 2. The results of the quantitative analyses of the thermogram (˚C)

Region of interest (ROI)	Values	Initial				Final			
		front		back		front		back	
		Left leg	Right leg	Left leg	Right leg	Left leg	Right leg	Left leg	Right leg
Thigh	max	33.1	33.8	33.1	33.3	33.9	35	34	33.9
	min	30.8	29.2	29.2	30.9	31.1	31.8	31.8	32.2
	average	32	32.2	31.8	31.9	32.8	33.3	32.8	32.9
Knee	max	34.5	33.1	34.4	34.4	34.4	33.4	34.1	34.8
	min	31.5	30.7	32.1	30.2	31.3	30.8	31.8	32.1
	average	33.7	32.1	33.1	33.2	32.5	31.9	32.8	33.2
Lower leg	max	33.9	33.8	33.4	32.7	33.3	34	33.6	33.3
	min	26.7	29.3	30.2	30	30.2	30.7	30.6	30.3
	average	32.7	32.6	32	31.9	31.9	32.6	31.9	32.2
Upper part of lower leg	max			33.5	32.8			33.6	33.3
	min			25.4	25.7			24.6	24.7
	average			31.8	31.6			31.9	32.1

DISCUSSION

This research examines temperature asymmetry of the lower extremities in an examinee with the ASL injury before and after specific 4-week physical preparation and rehabilitation program. The temperature of the surface of the body was taken using infrared thermography. Thermography is a safe and non-invasive method which has no side effects and which can be used for monitoring the temperature of the surface of the body and the dynamics of temperature changes, which can further be used in diagnosing sports injuries. The research started with the assumption that the temperature of the injured leg would be somewhat higher than the temperature of the healthy one, and that this difference would be reduced after a 4-week training program. Relying on the research conducted so far, we can conclude that the left and the right side of the body shown on thermograms in a healthy person should be symmetrical (Vardasca, 2008; Selfe, Whitaker, & Hardaker, 2008). Different authors give different limit values of contralateral differences in temperature which could indicate some kind of injury or abnormality in the functioning of the locomotor apparatus. Feldman & Nickoloff (1984) believe that the difference larger than 0,62˚C represents reference value for diagnosing the existence of some kind of abnormality. On the other hand, there are also authors who believe that any asymmetry which surpasses 0,7˚C, can be defined as abnormality and can indicate certain undesirable anatomical or physiological changes of the musculoskeletal system (Hilderbrandt, Raschner, & Ammer, 2010). The results of the presented research show the difference at the initial measuring in the knee region of even 1,6˚C, which undoubtedly confirms our expectations, that is, it confirms that the ACL injury will lead to the increase of the knee temperature. The monitoring of the difference in temperature and its dynamics is of great importance for sports practice because it is considered that the establishing of the balance between the right and the left side ensures proper recovery of the athlete. After four weeks, the difference in temperature between the right and the left knee at the final measuring was just 0,6˚C, which is really a significant improvement and it supports the conducted rehabilitation process. The differences between the left and the right side at the initial measuring in other regions of the frontal side did not surpass 0,2˚C, thus we cannot claim that there was any disorder here. However, an interesting thing was noticed at the final measuring; namely, there was an increase in temperature in the thigh and lower leg region of the healthy leg, whereas the temperature of the chosen thigh and lower leg regions of the left leg which had the ACL injury decreased. The reason for this change was probably the examinee's attempt to "save", that is, not to overload the left leg due to the increased physical activity level during the rehabilitation process. This corresponds with the results obtained by Čoh i Širok (2007) in their research where they examined temperature reaction of the body surface depending on the load itself. They showed that greater load leads to greater increase in temperature. When it comes to the back side of the body, the difference in temperature between the left and the right side did not surpass 0,4˚C, which means that there was no significant discrepancy from the symmetry. It can, however, be pointed out that the temperature of the back part of the leg and of the right and left thigh, when compared to the initial measuring, was higher by 1˚C each, which is, actually, an adaptable reaction of the musculature to the specific physical preparation 4-week program.

CONCLUSION

Even though the infrared thermography results cannot be considered fully convincing in terms of providing the final diagnostics of the current state of an athlete, they certainly show us the way that will lead us to further diagnostic procedures which could give a more precise diagnostics and explain the abnormality of the temperature dynamics. This research showed that pathophysiological changes, which include sports injuries as well, cause inflammatory processes which further cause local increase in temperature around the injury itself. If the existence of the sports injury is confirmed, the rehabilitation process can be monitored with a thermovision camera. After a few days or weeks, this rehabilitation process should bring the temperature of the injured spot down to its normal values. This research was conducted with only one examinee and the obtained results were the expected ones. However, thermographic changes and symmetry should be analyzed in further research which would include more examinees with ACL injury.

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SPECIFIC FIELD TESTS USED IN JUDO

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SUMMARY

By executing motor and functional tests we are gaining insight into athletes physical condition which surely is of great importance for achieving good results in the competition. Problem with this tests is that they aren't sport specific. For this reason it is better to conduct the tests that include some sport specific movements in the procedure. In judo, few sport specific tests are recomended by sport scientists. The aim of this paper is to introduce three tests that are presented in scientific papers available to authors. So far the most used are Special judo fitness test and Uchi komi fitness test. Since they are based on good methodolgy, they can be used like field test that can measure current sport specific condition of the judoka.

Keywords: judo test, judo fitness test

INTRODUCTION

Judo, which, when literally translated means "the gentle way" or "the easy way" (ju - tenderness, giving in; do – way, path), was created in 1882 by the traditional Japanese art of jujitsu and represents its finer version. This is a high intensity combat sport (Franchini, de Moreas Bertuzzi, Takito, Kiss, 2009; Franchini, Vecchio, Matsushigue, Guilherme, 2011), which consists of a plurality of different techniques and combinations thereof.

The action in the sport fight should be performed strongly and quickly, at the right time. Mainly these actions take place using anaerobic metabolism. The period of the fight without "entering" technique is usually performed under aerobic conditions. Also, the importance of aerobic endurance is reflected in the recovery between matches (Stojanović, Ostojić, Drid, Milošević, 2009).

Achieving top results requires developed motor skills, as well as sufficient energy capacity. It is important to determine the level of motor skills, but we cannot rely only on tests for the assessment with regard to the fact that the technical and tactical training, according to the coaches, is one of the most essential items necessary for success in the competition (Sterkowicz, Garcia & Lerma, 2007). It often happens that technically highly skilled athletes do not demonstrate anticipated results on tests of motor and functional abilities. It happens that these are highly ranked athletes who compensate their shortcomings with good technique and some specifics at the competition. In a certain period of sports career they will be forced to compensate for disadvantages. Because of this, specific tests that can be the best way to show the results of athletes for a particular branch of sport are necessary (Drid, Stojanovic, Trivić, Ostojic, Casals & Sterkowicz–Przybycien, 2014).

Overall, the tests can be divided into laboratory and field. Laboratory tests mainly estimate basic fitness abilities, while field tests evaluate basic skills and specific fitness abilities (Drid, Stojanovic, Trivić, Ostojic, Casals & Sterkowicz–Przybycien, 2014).

The aim of this work is to present specific field tests used in judo.

METHODS

For the collection of the available researches, the following electronic databases have been screened: PubMed and SCOPUS. The papers were searched during the period from 2000 to 2015. When searching the databases, the following key words have been used: judo test. Found titles of the researches, abstracts and full texts were then read and analyzed. In order for the research to be accepted for final analysis it had to meet the criteria: that the study used a test that contains an element of judo techniques.

RESULTS

Special judo fitness test

The test which evaluates anaerobic-aerobic endurance, strength, speed, power and technique required only by judo athletes is a Special judo fitness test (SJFT). Given that judo is a sport of high intensity, in which the effective duration of the regular battles is 5 minutes, professor Sterkovič devised a test that correlates with the actions during the match.

The test is performed on a mat (tatami). For its performance, it is necessary to have three judokas/judo practitioners from same weight category, arranged in a line. In the middle is the respondent, and to its both sides, at a distance of 3 meters, are two other judokas (Figure 1).

At the initial sign, the person being tested starts at throwing Ipon Seoi Nage, at maximum speed, both athletes, one at a time, who are standing at the ends with the overall distance of 6 meters. The test is carried out in three series. The first lasts 15 seconds, and the second and third 30 seconds. Between series there is a break of 10 seconds.

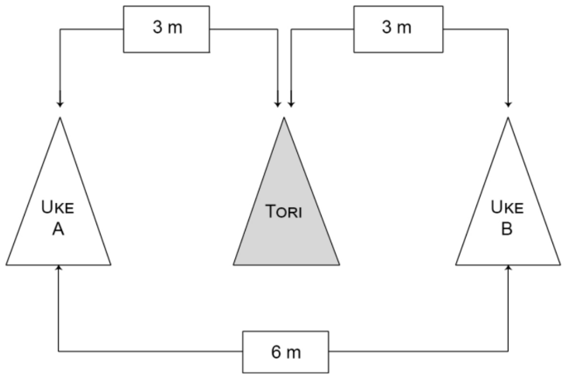

Figure 1. Positions in Special judo fitness test

The respondent is all the time wearing a heart rate monitor to measure the heart rate. It is measured immediately after the performed test and also after a minute break.

Franchini, del Vecchio, & Sterkowicz (2009) have made the chart with the classificatory norms for the total number of throws, heart rate and index of SJFT (Table 1). To calculate the index, the following formula is used:

Index = HR after the test + HR 1min after the test/N

where N represents the total number of performed throws.

Table 1.

Classification	**Variable**			
	Total no. of throws	**HR after**	**HR 1min after**	**Index**
Excellent	≥29	≤173	≤143	≤11,73
Good	27-28	144-161	144-161	11,74-13,03
Average	26	162-165	162-165	13,04-13,94
Bad	25	166-174	166-174	13,95-14,84
Very bad	≤24	≥175	≥175	≥14,84
HR – heart rate				

Specific judo fitness test

In a survey conducted by Lidor, Melnik, Bilkevitz & Falk (2006) a description of the specific test judo skills has been provide (Table 2). The test consists of 10 stations, five of which (2, 4, 6, 8, 10) are closely related to judo, while the remaining five (1, 3, 5, 7, 9) are for motoric ability.

Table 2.

10 stations of specific judo test	
Station	**Activity**
1.	4*8metra shuttle run
2.	Throw technique Ipon Seoi Nage by choice – left or right side
3.	Climbing the rope at a height of 3.3m, only hands
4.	10 escapes from Kesa Gatame intervention, left or right side by choice
5.	10 skips over the bench 15cm height with legs connected
6.	Throw technique Ouchi Gari, left or right side by choice
7.	25 sit-ups in which the legs are raised to the bench, back glued to the floor, the angle between knees and hips is 90^0 and hands are behind the head. A sit-up is counted only when the elbows touch the knees and back returns to the mat
8.	Escape from Yoko Shiho Gatame, left or right side by choice
9.	20 push-ups where the hands are placed on the mat and the legs are on the bench. One push-up counts when the chest hit the floor, and then elbows make full extension
10.	Throw technique of choice, left or right side

In one study Lidor et al. (2005) have come to the conclusion that coaches, when trying selections and predictions of future performance in young judokas mainly use the standard common tests batteries. They wanted to examine how the implementation of a Specific judo fitness test can contribute to the development and selection of talents in judo. They have conducted a test of general exercises (push-ups, crunches, alternating jumps over the bench), but also a unique Specific judo fitness test. They tracked whether the results on all the tests correlate with their success after one and after eight years.

However they came to the results which indicate that the tests do not correlate with later success. As a result, the authors suggest future research in the field of testing judokas which would have significantly more predictive power.

Uchi Komi Fitness Test

Almansba, Sterkowicz, Sterkowicz-Przybycien, & Comtois, (2011) have done research over seven male judokas. The study used Uchi Komi Fitness Test lasting 3min 43sec in six series. Duration of the same is 23sec and each subsequent increases by 3sec. The break between series is 4sec, with 2sec increase before the next. Subjects in one series perform two sequences. The first sequence is 3sec of static holding the sleeve of a kimono. In another, at the maximum speed enters the technique Ipon Seoi Nage over one judoka, then, at the same rate comes to the second athlete and enters the technique Sode Tsuri Komi Goshi (Figure 2).

The reliability of the test was found in the range of 0.7-0.9 which puts it in a highly reliable tests.

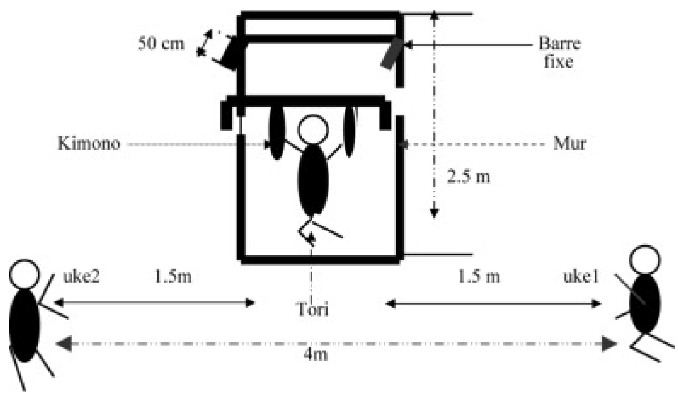

Figure 2. Position in Uchi Komi Fitness Test

DISCUSSION

In research conducted by Sterkowicz, Zuchowicz, & Kubica (1999) it was confirmed that there is positive correlation between number of throws in SJFT and Wingate test for upper and lower extremities. This fact contributed to a broader use of this test.

Franchini, Takito, Kiss, & Strerkowicz (2005) by using SJFT explored the differences between elite and non-elite judokas in Brazil. The elite judokas has a higher number of throws. After the test, while measuring heart rate there was no statistically significant difference, but there was some in the index of SJFT in favor of the top judokas.

Boguzewska, Boguzewski, Busko (2010) in one study attempted to compare the biomechanical and special methods of control of the judo training process. They concluded that in the training process should be used biomechanical measurements, general physical fitness tests and special fitness tests for a particular sport such as SJFT for judo to achieve optimal control of the training process.

Miarka, Del Vecchio, & Franchini (2012) conducted a study in which they compared the short-term effects of plyometric exercise, a combination of strength training and plyometric exercise and performance of SJFT in a maximum power. Their study indicates that the combined training and plyometric exercises that are performed before SJFT can lead to improvements in the test as well as to anaerobic power in judokas.

Uchi Komi Fitness test is used by coaches to develop physical strength and technical ability in judo athletes. Physiological requirements in this test are perhaps the most similar to competitive conditions. In many ways it reflects the requirements that exist before the judokas during the competitive fight, and can be used to predict the current capabilities of judo athletes at different stages of the training process (Almansba, Parent, Boucher & Comtois, 2012).

CONCLUSION

Of all the tests presented in the research SJFT was mostly used. It is the first specific test, which was introduced by the referential scientists engaged in judo research, while not requiring significant financial investment to be implemented. For these reasons, the number of studies that use this test is quite large in comparison to the number of studies that use the other two presented tests.

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DIFFERENCES IN SOME MOTOR SKILLS BETWEEN YOUNG KARATE ATHLETES

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SUMMARY

Well developed motor skills are necessery for success in karate, martial art and combat sport that have two ways of competing, sport fight and kata. It is expected that karate training have positive influence on development of all motor abilities. Still, coaches should especially pay attention to explosive strength, speed and coordination because these skills are most important for success in the competition. Aim of this research was to examine if there are significant differneces in motor abilities between young karatekas aged 12 and 14. Results have shown that there are differences. On the univariate level there were differences in the results of the tests that have measured explosive power, speed and flexibility.

Keywords: motor skills, explosive strength, speed

INTRODUCTION

Success in sport is a resultant of many components mutually conditioned in a single activity, i.e. the sum of anthropometric, motor, mental and other factors. Karate is characterized by a large number of techniques, which requires from karateka the adoption of enormous amount of information enabling him to perceive the essential elements of the techniques in order to be able to predict the intentions of opponents and react adequately. For successful analysis of the effects of training, it is crucial to satisfactorily resolve the issue of the training process (plan, program and control of the training) and a selection of those methodological procedures appropriate to the problem being investigated. In the sports battle aerobic energy sources are mostly used (77.8 ± 5.8%), although for the key actions anaerobic alactic energy sources are being used (16.0 ± 4.6%) (Beneke, Beyer, Jachner, Erasmus, & Hütler, 2004). Taking into account these facts, the karate match can be considered a physical activity dominated by aerobic metabolism, but for actions that result in points the most important is alactic anaerobic metabolism. Although karate has such specific demands, there are not many adequate tests to be used. (Nunan, 2006; Sterkowicz, & Franchini, 2009).

Anthropological dimensions can be changed in quantitative terms (increase or decrease in the efficiency of some abilities or motor information) and qualitative terms (change in the balance abilities and motor information). Complex activity of karateka during the combat requires adequate knowledge and capabilities, i.e., appropriate dimensions of psychosomatic status. Achieving top results in this sport requires years of intense training and competition experience, especially attention should be paid to the development of functional and motor skills. Transformation of athletes' state is most often manifested in the area of some skills and qualities in the field of motor skills. Monitoring of changes in certain motor abilities during the development of young athletes is even more important, because we can provide a realistic picture of which motor skills are essential to success in karate.

The main objective of this research is to determine the difference between the measured motor abilities of young karateka aged 14 and 12 years.

METHODS

The measurement of motor skills is organized in the period from 17 to 20 hours in the room where the training of karateka takes place. The conditions for carrying out measurements were optimal, with good lighting and temperature of 18-22°C, and tests were sorted in groups in order to, as much as possible eliminate the impact of fatigue on the results of other tests. A break within testing of the karateka continued until complete recovery of the athlete.

The study included 68 young karateka 35 of which were fourteen and 33 those who are twelve years old. Fifteen motor variables have been applied. A multivariate analysis of variance was used to determine the differences.

For this measurement program significant motor dimensions were estimated using the following measuring instruments. To assess the explosive strength: long jump from stationary position in cm (MSDALj), throwing a medicine ball from lying position (MBMLP), triple jump from stationary position in cm (MTROM). For measuring velocity: 20 meters sprint from high start in seconds (M20MS), hand tapping - the number of repetitions in 15 seconds (MTAPR), leg tapping - the number of repetitions in 15 seconds (MTAPN). For the evaluation of coordination: polygon backwards in seconds (MPOLN), side steps in seconds (MKORS), 5x10 meters per second (M5X10M). For the evaluation of flexibility: full extensions on a bench in cm (MDPRK), flex movement with a stick (MISKP), bend astride in cm (MPRAS). For the evaluation of repetitive strength: push-ups - the number of repetitions to failure (MSKLEK), sit-ups from a lying position - the number of repetitions to failure (MPTRUP), chin-ups on the shaft - the number of repetitions to failure (MZGIB).

Statistical analysis

In order to examine potential differences between the experimental groups, a multivariate analysis of variance (MANOVA) has been applied. Differences between groups for each variable and measure individually were determined by univariate analysis of variance (ANOVA). The confidence level of $p < 0.05$ have been selected to limit the significance values.

RESULTS

Table 1. Multivariate difference between groups I and II - motor skills

Wilks Value	F	Effect - df	Error - df	p
0.438	**4.433**	**15**	**52**	**0.000**

Table 2. Univariate differences between groups I and II - motor skills

Variables	Group	N	Mean	SD	F	P
MSDALJ	**group I**	**35**	188.11	22.710	2.5825	0.1128
	group II	**33**	179.85	19.463		
MBMLP	**group I**	**35**	8.85	1.818	13.7100	**0.0004**
	group II	**33**	7.30	1.610		
MTROM	**group I**	**35**	555.71	64.319	4.2516	**0.0432**
	group II	**33**	527.79	45.061		
M20MS	**group I**	**35**	3.80	0.330	2.2344	0.1397
	group II	**33**	3.92	0.328		
MTAPR	**group I**	**35**	31.91	3.043	12.4113	**0.0008**
	group II	**33**	29.24	3.212		
MTAPN	**group I**	**35**	26.00	2.437	13.7630	**0.0004**
	group II	**33**	24.12	1.635		
MPOLN	**group I**	**35**	12.39	2.509	4.5965	**0.0357**
	group II	**33**	13.66	2.361		
MKORS	**group I**	**35**	10.44	1.142	0.0037	0.9515
	group II	**33**	13.66	1.039		
M5X10M	**group I**	**35**	13.92	1.092	0.7573	0.3873
	group II	**33**	14.14	1.051		
MDPRK	**group I**	**35**	44.87	6.195	26.5394	**0.0000**
	group II	**33**	34.48	10.081		
MISKP	**group I**	**35**	53.66	10.508	28.9153	**0.0000**
	group II	**33**	34.18	18.499		
MPRAS	**group I**	**35**	48.14	7.807	22.5068	**0.0000**
	group II	**33**	32.27	18.091		
MSKLEK	**group I**	**35**	29.69	12.513	7.4838	**0.0080**
	group II	**33**	22.09	10.181		
MPTRUP	**group I**	**35**	70.71	22.445	0.8426	0.3620
	group II	**33**	65.64	23.169		
MZGIB	**group I**	**35**	6.49	4.104	1.5335	0.2200
	group II	**33**	5.36	3.296		

With the results of analysis shown in Table 1, which show a multivariate analysis of variance between the group in motor skills in young karateka, it can be concluded that the groups differ significantly in the level of motor skills (p =.00).

With further analysis of the univariate level, we can see that the motor variables of throwing a medicine ball, triple jump from the scene, hand tapping, leg tapping, polygon backward, deep forward bend, flex movement, bend astride and push-ups contribute most to the difference between groups of participants. Thus, the motor variables that measured explosive power, speed and flexibility contributed most to the difference between groups. This difference is expressed in the way that the subjects from the first group had better results in the value of the variables mentioned above. Due to the fact that in the research conducted by Blazevic, Katic, & Popovic (2006) strength, speed and coordination are the factors that are important for success in karate, the results point to the fact that the respondents of the first researched group have been well selected and that they had correctly programmed training activity. The problem of planning the training process is the most complex in the theory of sports training due to many factors which influence differently on all types of preparation of athletes, and therefore on sports results. The plan and program of training are the key documents by which the process of sports preparation is being realized and the effects that are achieved by their application are being controlled

DISCUSSION

Periodization of sports training is an important part of planning and programming in karate. Coaches and entire professional teams use periodization training in order for the athletes to achieve optimal effects of training work in each cycle, but, more importantly, to reach the top, that is the best result in the most important moment of the annual cycle (Bompa, 1999). Juniors are strongly recommended to apply one-cycle model of periodization. The main advantage of this model of periodization is a long preparatory period which does not maintain competition. This allows work on improving the techniques of karate, as well as the work on building strong foundations of physical preparation. The application of this model of periodization allows significant period in which it is possible to work on the development of fundamental skills that affect sport achievement in karate.

Key factors for success in karate fight are explosive strength, speed and coordination (Blazevic, Katic, & Popovic, 2006). Since there is significant difference in explosive strength and speed between two groups, we assume that training load was well planned. More experienced karatekas (14 years old) had more time to develop these motoric skills. In study conducted by Kovac, Bratic, & Vujkov (2011) it was confirmed that six month of karate training have influence on explosive strength and speed, so these results was to be expected. Never the less, it was expected that repetitive strength will also be improved. Lack of this improvement could be due to training regime that is more speed and force oriented.

CONCLUSION

It is of great importance to follow physical development of young athletes. Through well designed training programs karatekas should improve their motor abilities, especially explosive strength speed and coordination. More studies in the field of motoric skills needs to be conducted in order to establish what is desirable quantitative value for each age and each motoric skill.

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DIFFERENCE OF THE CERTAIN TECHNICAL-TACTICAL CHARACTERISTICS OF ELITE FREE-STYLE WRESTLERS IN SUCCESS FUNCTION

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SUMMARY

Research of the competitive activity in wrestling aims to carry out the modeling of the competitive activity accordingly, and based on those indicators provide the maximum efficiency in the fight by training activity of the wrestler. The study of free-style wrestler's competitive activity presents the subject of this research. As a sample, it has been used 6 categories of the European Championship 2014 in Finland and the First European Olympics 2015 in Azerbaijan. The main goal for this work is to overview the specificity of technical-tactical impact of elite free-style wrestler in the success function, based on indicators of their competitive activity. By processing the big sample of fights in two elite competitions, the main parameters of success, which characterize medalists on the above stated competitions, have been defined. The results of the research show that there has been no drastic differences in the percentual representation of techniques between groups, but that the most discriminating factors that influence success, i.e. the things by which medalists differ in their competitive activity from other groups have been: the orientation of technical effects in standing position, less time needed to score a point, i.e. to perform an action, the bigger number of actions per fight, and of course that the average value of points of all realized actions is significantly bigger than other, low-ranked, groups.

Key words: wrestling, free-style, competitive activity, factors of success.

INTRODUCTION

Research of competitive activity is getting more and more topical in modern sports' theory and practice nowadays, and is getting more and more affirmated as a special group of research with a specific methodology. Competitive activity in different sport branches is conditioned with characteristics of those branches (Hughes and Franks, 2008). In less complex, monostructural sports, research of competitive activity is relatively easy. On the other hand, polistructural and complex branches of sport are noticeably harder for these types of research. Among which, a special place occupy martial branches of sport which include wrestling. Results that describe sportsmen's competitive activity belong with indicators which in the most direct way possible depict the connection between the process of preparation and results in the specific branch of sport (Tünnemann, 1996). Notation and analysis of the most significant parameters of competitive activity, quantitative determination of the influence and mutual connection of those parameters, as well as the explanation of their dependency and connection with certain aspects of preparation, present a very important and delicate research task. Of course, this type of research make real sense only when realized in conditions of expressed directivity towards maximum result, i.e. on the most important competitions (Jovanović et al., 2010).

Analysis of competitive activity is the basic method thanks to which the information about the level of preparedness, i.e. competitive preparedness of some athlete or sport team is provided. In relation to the structure of information by applying the analysis of competitive activity, information of the tactical aspect of sportsman's performance can be provided. Models of the tactic, i.e. tactical efficiency of competitive performance can be determined by results obtained by applying the analysis of competitive activity (Dopsaj, 2009).

In wrestling, an extraordinary dynamic of activity of both competitors is present, with a clear change in tempo and rhythm of the fight, constant change of offensive and defensive activities and other forms of motoric manifestations, depending on variable situational conditions. Because of that, identification of indicators of competitive activity, their registration, interpretation and usage for explaining competitive activity in martial sports present methodologically complex task, and for quality planning and programming of the training process, constant monitoring of competitive activity is necessary. The choice of the fitting strategy during competition inevitably demands monitoring of their own, as well as their opponent's qualities and flaws (Petrušić, 2002).

Competitive activity in wrestling presents the way competitors in competitive conditions function, in accordance with wrestling rules, and they directly depend on his preparedness. Technical, tactical, psychological, conditional and theoretical preparation of the wrestler have been put into the improvement of competitive activity function, but indicators of competitive activity also directly influence all the above stated segments of wrestler's preparation. Analysis of competitive activity unambiguously show which elements of technique are used the most, which details of the tactic have particular significance, thus direction in which conditional and psychological preparation of the wrestler should be directed. The success in wrestling is an indicator of good synchronization of all these factors, which enable successful manifesting of required knowledge and skills, and indicators of competitive activity 'discover' the way that those factors of preparation manifest in wrestling fight (Tuenneman, 2004).

The subject of this work is elite free style wrestlers' competitive activity, which has been analyzed on European Championship 2014 and the First European Olympic Games 2015. When defining the subject of the work, the start point was the fact that flow and dynamic of the fight depend on: content and type of technique, duration of time in which the technique is performed, influence of distracting factors and level of motoric base of the respondent. The main goal for this work is to overview the specificity of technical-tactical impact of elite free-style wrestler in the success function, based on indicators of their competitive activity.

Because of that, this work should contribute to better overview of competitive activity in wrestling sport and to give concrete contribution to improving the analysis and understanding of competitive activity in wrestling, i.e. to single out technical elements that are more frequently used and that contribute to higher rate of success of free style wrestler.

METHODOLOGY OF RESEARCH

Gathering information in this research of transversal character is carried out with the method of observation, i.e. by analyzing the official reports (record-bulletin) and video materials of fights during the European Championship 2014 and the First European Olympic Games 2015. In comparison to the basic method, this work belongs to category of natural research according to its character, not experimental. In comparison to the type of research, this work possesses characteristics of both fundamental and applied research as it provides the innovation of the already existing knowledge in the field of training technology with elite free style wrestlers that can be practically applied. The basic method of knowledge in this work will be inductive reasoning because the success of wrestlers will be explained based on single indicators of competitive activity.

Sample of the research

As a sample of the research work, 6 Olympic fights out of 8 categories in total realized on European Championship 2014 and the First European Olympic Games 2015 were analyzed. Total number of fights that was used as a sample make 273 fights. In the competition of 2014, the number of sample of processed fights was 127. Whereas, 146 fights make fights in 2015. Rational typology of competitors is carried out adequately by the placement accomplished on the final ranking list: from 1st to 3rd place – 196 records of competitive activity, from 5th to 8th place – 164 records of competitive activity, and from 9th to the the very last place on the final ranking list 186 records of competitive activity

Variables

Competitive activity of the wrestler within monitored competitions is presented via quantified indicators of frequency of repetition of every element and its submodalities. The obtained data of frequency of modality of every element of competitive activity is presented via total value, average value per fight and percentual values of frequency of modalities in comparison to total registration of frequency of elements.

Elements of competitive activity that have been analyzed, have at the same time presented original variables in the research: placement (1 to 3 – 1, 5 to 8 – 2, 9 until the end – 3), percentual representation of actions according to value, percentual representation of actions in standing position and parterre, representation of techniques in parterre.

Based on original variables, variables that have been defined and derived by applying the method of index are as follows: intensity of scoring points and rounds, intensity of scoring points II round, summarized intensity of scoring points, intensity of actions in standing position, intensity of actions in parterre, summarized intensity of actions, efficiency of actions in standing position, efficiency of actions in parterre, summarized efficiency of actions.

STATISTICS

Raw results of all variables used in this research are submitted to calculation of basic descriptive statistics as follows – measures of central tendency (MEAN) and measures of dispersion (SD, cV%, Std. Eror absolutely and relatively). For the purpose of determining differences between subsamples of respondents, the multiple analysis of variance is used – MANOVA, while the univariate analysis of variance is used for partial level – ANOVA. The difference between pairs of single variables of tested subsamples is determined by Bonferroni test criteria. For determining structure and set of functions that are most influential, i.e. that describe differences between surveyed wrestlers' groups, Discriminant analysis is used. All statistic analysis are realized by using the statistic software SPSS 19.0, while the level of statistical significance is defined for 95% probability and value $p < 0.05$ (Hair et al., 1998).

RESULTS

In Table 1, representation of actions according to their values is shown, but also detailed representation of all techniques by surveyed groups.

Table 1. – Descriptive statistic of dominant techniques of all three surveyed groups.

Descriptive Statistics(a)											Tot. Act.	Mean
Values of actions and type of actions per groups			N	Min	Max	Mean			St. D.	Cv%		
			Stat.	Stat.	Stat.	Stat.	%	St.Er.	Stat.	Stat.		
From 1st to 3rd place	1 point	Standing posit.	196	0	5	0.42	**12.8**	0.06	0.8	191.9	641	**3.27**
		Parterre	196	0	4	0.17	**5.3**	0.04	0.53	303.65		
	2 points	Standing posit.	196	0	6	1.7	**52.1**	0.10	1.46	85.38		
		Parterre	196	0	4	0.68	**20.9**	0.07	1.02	149.75		
	4 points		196	0	2	0.29	**8.94**	0.04	0.55	187.6		
	Actions in standing position	Throws	196	0	2	0.17	**5.3**	0.03	0.42	241.07	641	**3.27**
		Takedowns	196	0	3	0.33	**9.98**	0.04	0.6	182.31		
		Pushouts	196	0	4	0.4	**12.3**	0.05	0.77	190.66		
		Counter	196	0	1	0.04	**1.25**	0.01	0.2	486.01		
		LOB	196	0	6	1.47	**44.9**	0.10	1.39	94.35		
	Actions in parterre	LOB	196	0	2	0.03	**0.94**	0.01	0.2	654.02		
		Moves in part.	196	0	6	0.74	**22.6**	0.08	1.12	151.74		
		Counter	196	0	2	0.07	**2.03**	0.02	0.27	405.96		
		Pin pos.	196	0	2	0.02	**0.62**	0.01	0.17	853.65		
From 5th to 8th place	1 point	Standing posit.	164	0	6	0.4	**18**	0.06	0.76	190.8	362	**2.21**
		Parterre	164	0	3	0.12	**5.52**	0.03	0.38	311.8		
	2 points	Standing posit.	164	0	5	1.09	**49.5**	0.10	1.22	112		
		Parterre	164	0	7	0.48	**21.6**	0.08	1.01	210.7		
	4 points		164	0	2	0.12	**5.52**	0.03	0.36	298.2		
	Actions in standing position	Throws	164	0	2	0.14	**6.35**	0.03	0.37	260.6	362	**2.21**
		Takedowns	164	0	3	0.16	**7.18**	0.03	0.44	278.9		
		Pushouts	164	0	6	0.37	**16.9**	0.06	0.75	202.3		
		Counter	164	0	1	0.02	**1.1**	0.01	0.15	634.4		
		LOB	164	0	4	0.9	**40.6**	0.08	1.08	120.8		
	Actions in parterre	LOB	164	0	2	0.04	**1.93**	0.02	0.23	541.3		
		Moves in part.	164	0	7	0.48	**21.6**	0.08	1.09	228.7		
		Counter	164	0	1	0.07	**3.04**	0.02	0.25	374.1		
		Pin pos.	164	0	1	0.03	**1.38**	0.01	0.17	565.6		

From 9th until the end	1 point	Standing posit.	186	0	3	0.31	**20.1**	0.04	0.58	188.19	283	**1.52**
		Parterre	186	0	3	0.12	**8.13**	0.03	0.39	315.49		
	2 points	Standing posit.	186	0	7	0.76	**50.2**	0.09	1.17	152.75		
		Parterre	186	0	4	0.24	**15.9**	0.05	0.66	272		
	4 points		186	0	2	0.09	**5.65**	0.02	0.3	348.47		
	Actions in standing position	Throws	186	0	2	0.07	**4.59**	0.02	0.28	394.88	283	**1.52**
		Takedowns	186	0	2	0.11	**7.07**	0.03	0.36	333.92		
		Pushouts	186	0	3	0.3	**19.4**	0.04	0.56	190.55		
		Counter	186	0	1	0.01	**0.71**	0.01	0.1	961.76		
		LOB	186	0	6	0.67	**43.8**	0.08	1.05	158.03		
	Actions in parterre	LOB	186	0	1	0.05	**3.18**	0.02	0.22	444.67		
		Moves in part.	186	0	4	0.24	**15.9**	0.05	0.7	288.47		
		Counter	186	0	1	0.04	**2.47**	0.01	0.19	507.05		
		Pin pos.	186	0	2	0.04	**2.83**	0.02	0.23	531.17		

In Table 2 and 3, results of differences (MANOVA and ANOVA) of observed indexes in relation to belonging of formal groups and in relation to final ranking list are shown.

Table 2. – Results of multiple analysis of variance - MANOVE

MANOVA - Multivariate Tests (d)										
Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Powerb
Placement: 1to3 places - 1, 5to8 places - 2, 9until the end - 3	Wilks' Lambda	0.736	3.306^{a}	52.0	1036	**0.000**	0.142	171.906	1.000

Table 3. – Results of univariate static analysis - ANOVE

ANOVA - Tests of Between-Subjects Effects									
Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Powerb
Placement: 1to3–1, 5to8–2, 9until the end- 3	Summarized intensity of scoring points	171491,4	2	85745,72	10,58	**0,000**	0,038	21,161	0,989
	Intensity of actions in parterre	116465,2	2	58232,6	3,74	**0,024**	0,014	7,475	0,684
	Efficiency of actions in standing position	74,901	2	37,45	35,93	**0,000**	0,117	71,862	1,000
	Efficiency of actions in parterre	20,494	2	10,247	14,44	**0,000**	0,05	28,875	0,999
	Summarized efficiency of actions	55,454	2	27,727	33,34	**0,000**	0,109	66,685	1,000

Table 4. – Differences between pairs of groups in relation to examined variables

T test, Bonferroni criteria, Pairwise Comparisons							
						95% Confidence Int. for Diffe.	
Dependent Variable	(I) Placement:	(J) Placement:	Mean Differ.(I-J)	Std. Error	Sig.a	Lower Bound	Upper Bound
Summarized intensity of scoring points	Medals	From 5th to 8th place	-29,213*	9,527	**0,007**	-52,09	-6,334
		From 9th place on	-41,183*	9,215	**0,000**	-63,31	-19,054
	From 5th to 8th place	From 9th place on	-11,971	9,643	0,645	-35,13	11,186
Intensity of actions in parterre	Medals	From 5th to 8th place	12,431	13,21	1,000	-19,29	44,153
		From 9th place on	34,597*	12,777	**0,021**	3,913	65,28
	From 5th to 8th place	From 9th place on	22,166	13,371	0,294	-9,942	54,274
Efficiency of actions in standing posit.	Medals	From 5th to 8th place	0,571*	0,108	**0,000**	0,312	0,83
		From 9th place on	0,871*	0,105	**0,000**	0,62	1,122
	From 5th to 8th place	From 9th place on	0,300*	0,109	**0,019**	0,038	0,563
Efficiency of actions in parterre	Medals	From 5th to 8th place	0,266*	0,089	**0,009**	0,052	0,48
		From 9th place on	0,461*	0,086	**0,000**	0,254	0,668
	From 5th to 8th place	From 9th place on	0,196	0,09	0,092	-0,021	0,412
Summarized efficiency of actions	Medals	From 5th to 8th place	0,490*	0,097	**0,000**	0,258	0,721
		From 9th place on	0,750*	0,093	**0,000**	0,526	0,974
	From 5th to 8th place	From 9th place on	0,260*	0,098	**0,024**	0,026	0,495

Table 5. – Descriptive statistic of performed variables

Descriptive Statistics										
Groups	Variables	N	Min.	Max	Mean		Std. Dev.	cV%	Skew.	Kurt.
		Stat.	Stat.	Stat.	Stat.	Std. Er.	Stat.	Stat.	Stat.	Stat.
From 1st to 3rd place	Intensity of scoring a point 1st round	196	0	180	51.80	4.04	56.61	109.28	1.32	0.65
	Intensity of scoring a point 2nd round	196	0	180	39.81	3.21	44.95	112.91	1.57	2.43
	Summarized intensity of scoring points	196	0	360	54.41	4.00	56.02	102.97	2.91	12.38
	Intensity of actions in standing posit.	196	0	360	134.22	8.13	113.76	84.75	0.97	-0.17
	Intensity of actions in parterre	196	0	360	91.15	9.08	127.17	139.51	1.18	-0.04
	Summarized intensity of actions	196	0	360	110.06	7.29	102.09	92.76	1.32	1.04
	Efficiency of actions in standing posit.	196	0	4	1.93	0.07	0.96	49.76	0.02	0.81
	Efficiency of actions in parterre	196	0	2	0.85	0.07	0.93	109.95	0.29	-1.81
	Summarized efficiency of actions	196	0	4	1.89	0.06	0.83	44.11	-0.14	1.90
From 5th to 8th place	Intensity of scoring a point 1st round	164	0	180	51.65	4.78	61.23	118.55	1.15	0.09
	Intensity of scoring a point 2nd round	164	0	180	48.49	4.46	57.09	117.74	1.22	0.49
	Summarized intensity of scoring points	164	0	360	83.62	7.54	96.57	115.48	1.78	2.64
	Intensity of actions in standing position	164	0	360	139.77	10.32	132.12	94.53	0.62	-0.98
	Intensity of actions in parterre	164	0	360	78.72	10.26	131.40	166.92	1.38	0.25
	Summarized intensity of actions	164	0	360	124.84	9.61	123.11	98.62	0.87	-0.45
	Efficiency of actions in standing posit.	164	0	4	1.36	0.08	1.04	75.99	0.19	-0.25
	Efficiency of actions in parterre	164	0	2	0.58	0.07	0.85	146.79	0.89	-1.07
	Summarized efficiency of actions	164	0	4	1.40	0.07	0.95	68.00	-0.10	-0.31
From 9th place until the end	Intensity of scoring a point 1st round	186	0	180	48.32	4.70	64.16	132.78	1.15	-0.07
	Intensity of scoring a point 2nd round	186	0	180	40.45	4.35	59.31	146.62	1.40	0.72
	Summarized intensity of scoring points	186	0	360	95.59	8.12	110.74	115.84	1.26	0.62
	Intensity of actions in standing posit.	186	0	360	127.03	10.27	140.09	110.28	0.67	-1.07
	Intensity of actions in parterre	186	0	360	56.55	8.51	116.07	205.24	1.90	2.05
	Summarized intensity of actions	186	0	360	130.27	9.82	133.99	102.85	0.66	-0.98
	Efficiency of actions in standing posit.	186	0	4	1.06	0.08	1.07	100.35	0.57	-0.40
	Efficiency of actions in parterre	186	0	2	0.39	0.05	0.72	187.40	1.53	0.64
	Summarized efficiency of actions	186	0	4	1.14	0.07	0.96	84.21	0.14	-0.98

DISCUSSION

Tunnemann (2013) states that the key question for further improvement of performance in martial sports lies in enhancing the efficiency of the training. The start point for effective control of the training is description of the target performance that guarantees success (Eduardo and González, 2013).

By analyzing the results from the Table 1, we can establish representation and values of actions that are most frequently realized, dominance of realized techniques per groups, total number of actions realized per surveyed groups, but also the average value of realized actions per one record of competitive activity.

By observing results of representation of actions and their values individually by groups, we can notice that actions differ dominantly in 2 points in all three groups. In the first two groups, actions for two points are present in over 70% of technical effects, whereas in the third group that number is somewhat smaller with 66%. Also, we can see the difference in representation of the most valuable actions where medalist realized 8.94% of technical effects by 4 points out of total number of actions of surveyed groups, and second and third groups significantly less, 5.54% and 5.65% out of total number of actions. While values of action number for 1 point inversely proportional to actions of the biggest value. Which means that medalists realize actions for 1 point in standing position in 12.8% of the cases, group of from 5th to 8th place in 18% of the cases, whereas the lowest ranked ones in just 20.1% of the cases, and realize significantly more actions for 1 point in parterre fight and that is in 8.13% of actions. Dominance of actions with small percentage of risk is, among other things, consequence of the increase of action value of landing on the back, which is characterized by a small percentage of risk. Having this said, on the European Championship 2014, techniques for 2 points were dominant (Kasum and Marković, 2014).

Two ways of the fight is what characterizes wrestling, fighting in standing position and fighting in parterre. Individual characteristics of every wrestler are reflected in the dominant technique realized in a fight, whether it is in standing position or parterre, whereas some realize actions in both fighting positions just as good. If we take a look at the number of realized actions in a fight as actions realized in standing position, i.e. the technical effect started from standing position, and actions realized in parterre, we can see that the result we got was two measurable variables. In addition to that, we can see an absolute dominance of the fight in standing position over the opponent by looking at fights from all three of the surveyed groups, although the free style has a large number of techniques in parterre (Table 1). Compared to previous research, there are similar results (Marković and Kasum, 2013a), that have dealt with the analysis of competitive activity of final fights on World Championship 2013 and (Kasum and Marković, 2014), and that have dealt with the analysis of free style wrestlers' competitive activity on European Championship 2013, as well as 2014, and that came to a following conclusion: after the very start of applying the new rules, number of realized actions in standing position has increased significantly compared to parterre position.

Results that show dominance of technical effects that are used during fight the most, give the most useful date of competitive activity (Table 1). Surveyed groups single out the landing on the back as the most common technique with over 40% of realized actions in all three cases, takedowns and actions in parterre are somewhat more frequent with medalists than with other groups, whereas pushouts are frequent with the lowest ranked wrestlers. It is important to emphasize that the most attractive tosses that carry 4 points, have no significant exception so medalits realize tosses in 5.3% of the cases, group from 5th to 8th place in 6.35% of the cases, whereas lowest ranked wrestlers in 4.59% of the cases. Still, the results show that there were no bigger exceptions in percental representation of techniques with gurveyed groups.

Also, one more information needs to be mentioned – in 196 records of competitive activity of the first group of respondents, 641 action was realized, in 164 records of the second groups, 362 actions, whereas in 186 records of competitive activity of the third group, 283 actions. The difference in an average value of realized actions per competitor in a fight needs to be mentioned. Medalists in averge realize 3.27 actions per fight, whereas the second surveyed group realizes 2.21, and the lowest ranked surveyed group 1.52 actions per realized fight (Table 1).

By interpreting results from Table 2, which shows results of multiple analysis of variance – MANOVE, we can confirm assumptions that statistically significant differences between designed groups in manifestation of competitive activity exist. By further analysis of results that follow, i.e. results of univariate statistic analysis – ANOVE (Table 3), we can see the accurate variables in which statistically significant difference between surveyed groups occurs. By using the test, we will determine differences between pairs of groups in relation to examined variables (Table 4). This way we can find out between which groups individually in relation to a certain variable, an already established statistically significant difference exists (Table 3).

Intensity of leading the fight depends on tactical imagination of the coach and competitor, technical training of the competitor, and exclusively of physical preparation of the competitor himself. In this work, intensity of leading the fight is defined as an intensity of scoring points in a fight, and as intensity of realizing actions in fight. When we look at average values of variable of summarized intensity of making scores which for competitors from 1st to 3rd place is 1 point on every 54.41 seconds, from 5th to 8th place – 83.62 seconds, and for the group of the lowest ranked – 95.59 (Table 5). These results show statistically significant difference between first and second group on the level $p = 0.007$, and first and third group on the level $p = 0.000$ (Table 4). Also, statistically significant difference is present in variable – intensity of actions in parterre, between groups of medalist and lowest raked on the level $p = 0.021$ (Table 4). Even though significant different is present in only one relation between groups, a difference of average value of surveyed groups for variable can be clearly seen – summarized intensity of actions: first group realizes action on every 110.06 second, second group on every 124.84 second, whereas third group takes 130.27 seconds to realize one action (Table 5).

The previous variable gave us a crucial piece of information, but it is necessary to determine efficiency of those actions, i.e. what the average value of action in standing position, parterre, or summarized value of actions in fights is. Statistically significant difference is present between first and second group, and first and third group in variables efficiency of actions in standing position on the level $p = 0.000$ and $p = 0.000$, and efficiency of actions in parterre on the level $p = 0.009$ and $p = 0.000$, and summarized efficiency of actions on the level $p = 0.000$ and $p = 0.000$ (Table 4). Also, significant difference is present between second and third group in variables efficiency of actions in standing position on the level $p = 0.019$, and summarized efficiency of actions on the level $p = 0.024$ (Table 4). Efficiency of actions of first group in standing position was 1.93 pints, in parterre 0.85 points per action, whereas summarized value of action was 1.89 (Table 5). Second group achieved following results, in standing position 1.36 points, in parterre 0.58, and summarized value was 1.40 points per action (Table 5), and third group of respondents had the worst results of efficiency of actions in standing position – 1.06, in parterre 0.39, and summarized value of 1.14 points per action (Table 5). These results present significantly improved values of action's efficiency if we compare medalist group of this research to previous research (Markova and Kasum, 2013b), when previous rules were valid, and the sample of research included final fights of European Championship 2013. Back then, the efficiency of actions was 1.54 points per action. Thanks to the research professor Tünnemann did, and which included sample of World Championship 2013, we are given the following results – index of performances and efficiency of actions that mirror in enhancement of activity improved, as well as huge improvement in attackingly oriented fight (Tünnemann, 2013). Results from 2013 are completely confirmed with this research, which only shows an upgrade of previous research as well as its improvement.

CONCLUSION

Analysis of free style wrestler's competitive activity on European Championship 2014 and the First European Olympic Games 2015 is presented as a unique base, i.e. as a collection of records of competitive activity with 6 categories from above stated competitions which were used as a sample in order to single out factors that influence success.

For the coach, it is very important to analyze technical-tactical structure of the winner. It is important so that the analysis of technical capacity of their athletes can be compared to elite athletes by categories. Also, it is very important to plan the training process, and so is perfecting the concept of training of perspective young wrestlers.

As the final conclusion of this work, we can say that there are no bigger differences in percentual representation of techniques between groups, and through further conclusions we will define what is the thing that medalist differ in their competitive activity from other groups.

It is important to mention that generally more points are made in standing position in all three groups and that actions for 2 points are dominating. From that, we can conclude that medalist more attention pay to technical effects that are realized in standing position, and therefore they have somewhat bigger percentage of realized actions that are valuable the most. As far as intensity of leading the fight, it can be seen through two variables. The first variable presents intensity of scoring a point during fights, which is not such reliable information because of the difference in scoring value of action, and the second variable presents intensity of making actions in fight, i.e. how much time is needed for realization of one action no matter the scoring value. Both variables show visible differences of the time needed for scoring a point or action. Medalist take 54.41 seconds to score a point, which is almost 30 or 40 seconds less than for other two groups. Also, we can conclude that medalists take 15 to 20 seconds less than other two groups take for realizing one action. From that, we can conclude that medalists lead fights of higher intensity, i.e. that they make constant attacks with superior physical preparedness. We will just add one more information to this important conclusion and that is that besides taking far less time for realizing one action, an average value of those actions is significantly bigger as well, but also that the average number of realized actions per fight is higher, and so is the number of realized actions in total in medalists group.

The last change when it comes to rules imposes demands with high tempo of the fight, which means that wrestlers must be efficient from the very start of the wrestling fight, i.e. those who have succeeded to adjust to higher intensity of the fight and at the same time be efficient thanks to training process and for sure achieve success.

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HISTORICAL ASPECTS OF PERFORMANCE ANALYSIS IN JUDO

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SUMMARY

Increased interest of judo scientists for performance analysis is related to beginning of twenty first century. Until then analysis were usually conducted by the coaches and competitors for their personal needs, Afterwards it became a field of scientific interest. Technological development enabled the creation of special software which is used only in judo performance analysis (FRAMI, Saats™). There is also a different approach where researchers modify software that is used in other sports (Lince). Result is the expansion of scientific works in the subject of judo performance analysis. Most of them analyze technical-tactical details and time structure of the judo fight. Performance analysis is also used like an integral part of researches that have more than one subject (anthropometry, motoric skills, functional, physical fitness, Special judo fitness test, etc.). One of the reasons for increasing number of the articles with the subject of performance analysis is good positioning of the scientific journals which for their subject have combat sports (Archives of Budo) or performance analysis in sport (International Journal of Performance Analysis in Sports).

Keywords: situational efficiency, time structure, judo technique

INTRODUCTION

Performance analysis in judo had been used for a long time only by coaches and athletes. Only in the last 15 years it became the subject of intense interest of researchers, as can be inferred from the number of papers published in relevant scientific journals. During this period, most of the work in judo performance analysis has been produced by the authors from so-called Polish school (Krakow and Warsaw), among which most important are Sikorski, Sterkowicz, Leh and Boguševski. A large number of works in this field was published by Brazilian Franchini and associates, as well as authors Kajmović and Radjo of Bosnia and Herzegovina (Peseta, Ferrer Sapena, Villamón, González Toca-Herrera & Aleixandre, 2013). Recently, Japanese and Spanish authors also contributed with articles that are somewhere different in the methodological approach.

METHODS

Increased interest for this type of research, created a need for the creation of appropriate methods and tools to improve the work in this field, which led to the creation of two specialized software. Miarka and her colleagues created software (FRAMI) which is only used for performance analysis in judo (Miarka et al., 2011), while Marcon (Marcon) designed computer program (Saats™) that allows analysis of temporal structures of specific actions during judo fights and testing of inter and intra reliability of the evaluator (Marcon, Franchini, Jardim & Barros Neto, 2010).

In addition to these two programs, which are designed only for the purposes of performance analysis in judo, the researchers used other performance analysis programs that could be adapted for adequate use in judo. An example is the Lince software which was modified by Spanish authors (Courel, Franchini, Femia, Stankovic, & Escobar-Molina, 2014; Escobar-Molina, Courel, Franchini, Femia, & Stankovic, 2014)

RESULTS & DISCUSSION

Since the Olympic Games held in Tokyo in 1964, studies have been made that are aimed to extract information about the technical elements used with most success. In one of the first works of such nature, from 1978, a group of Japanese authors (Matsumoto, Takeuchi, & Nakamura, 1978) has published a lot of interesting data related to the nature of the fight in Kodokan scientific journal (type of attack, defense, place on the mat where technique is performed, etc.). Many authors (Boguszewski, 2006; Boguszewski & Boguszewski, 2006; Carratala, Garcia, Fernandes & Calvo, 2007; Escobar, Franchini & Padial, 2007; Matsumoto, Takeuchi & Nakamura, 1978; Monteiro, García & Carratalá, 2007; Sterkowicz & Franchini, 2000) have directed their research towards analyzes of technical action, structure of the fight and physiological profile of judoka that is corresponding to these parameters, providing a range of information useful in the design of training programs and preparation for the competition (for example, information about the techniques of control that followed throws, the typical techniques used in tachi waza, usage of techniques in relation to the category, the temporal structure of the combat, penalties, etc.).

Performance analysis in judo became very important over time, helping to define the relevant factors that affect the result in judo, both in scientific and in the professional sense. On the basis of it, it is possible to carry out the analysis of time-movement that will rely on the evidence from laboratory and field studies of sport physiology to explain the results in terms of the use of energy systems in a given sport. Based on such analysis specific training programs and fitness tests can be developed.

The foundation in research of temporal structure of judo fight had been set by Sikorski and associates (Sikorski, Mickiewicz, Milo & Laksa, 1987). In one of the first articles that examined the situational efficiency of judo competitors came to the conclusion that the average length of a combat sequence is 30 seconds, with an average length of a break of 10 seconds. The relationship between work time and break time is 2:1 and 3:1, more specifically from 20 to 30 seconds of work, after which followed a pause of about 10 seconds (Castarlenas & Planas, 1997; Sikorski et al., 1987; Van Malderen, Jacobs, Ramon, Zinzen, Deriemaeker & Clarys, 2006). By taking this information into account Franchini and Sterkowicz (Franchini, Nakamura, Takito, Kiss, Sterkowicz, 1998) had constructed a special judo fitness test, which is now used in practice for measuring the specific readiness of judokas.

In recent studies, the temporal structure of judo fight was the subject matter of Spanish (Hernández García & Torres Luque, 2007; Hernández García & Torres Luque, 2009; Gutierez-Santiago, Prieto, Camerino & Anguera, 2011) and Brazilian authors (Miarka, Panissa, Julio, Del Vecchio, Calmet & Franchini, 2012; Miarka et al., 2014). They point out that the judo match, on average, consists of seven combat sequences with an average duration of 20 to 23 seconds (Hernández & García Torres Luque, 2007; Hernández García & Torres Luque, 2009; Miarka et al., 2012).

In most of the works subject of analysis was situational efficiency in competitions, but often performance analysis of was used as an integral part of the research in which they measured some other factors, such as: anthropometric characteristics (Lech, Sterkowicz & Rukasz, 2007), motor skills (Lech et al . 2014), functional ability (Sikorski, Mickiewicz, Majle & Laksa, 1987; Lech, Tyka, Palka & Krawczyk, 2007; Lech, Palka, Sterkowicz, Tyka & Krawczyk, 2010; Lech, Tyka, Palka & Krawczyk, 2010) physical fitness (Sterkowicz, Blecharz & Lech, 2000), special judo fitness test (Sterkowicz, Blecharz & Lech, 2000) or the hand grip strength (Gutierrez Sanchez, Soria Dominguez, Perez Turpin, Cortell Tormo & Suarez Llorca, 2011). The sample size varied, so we have sample which consisted of only two fights (Boguszewski, 2006), while the largest sample consisted of 3950 matches (Franchini & Sterkowicz, 2003).

Different aspects of judo fights have been analyzed and we can clearly identify lines of research of some groups of authors. The line of research of Polish authors were related primarily to the index of fight dynamics, for which they point out that it is an important parameter of situational efficiency (Boguszewski, 2006; Boguszewski & Boguszewski 2006 Lech, Tyka, Palka & Krawczyuk, 2007; Sterkowicz, Lech & Almansba, 2007; Kruszevski, Jagiello & Adamiec, 2008; Boguszewski, 2010; Lech, Palka, Sterkowicz, Tyka, Krawczyuk, 2010; Lech, Tyka, Palka, Krawczyuk, 2010; Boguszewski, 2011a; Boguszewski, 2014). Boguszewski examined how judoka defend himself against an opponent's attack, when he is not using the counter attack. He concluded that the hand block and turn to the belly are least effective ways of defense (Boguszewski, 2009; Boguszewski, 2011b).

CONCLUSION

In general, the methodological approach is quite different from one author to another, so it cannot be determined a distinctive research model. Also, good positioning of the scientific journal Archives of Budo which publishes scientific papers in the field of martial arts, as well as the International Journal of Performance Analysis in Sports, which publishes scientific papers which have as their object performance analysis in sports, contributed significantly to the rice of popularity of performance analysis research in judo. Still, it is a field that has many blank spots and needs to be widely explored, thus further researches are necessary.

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Physical Education

INTERACTIVE METHODS OF EDUCATION

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SUMMARY

The present article is dedicated to an actual and important issue directed to increasing the quality and effectiveness of the education as key factor providing the social integration and successful realization of the individual. The changes effected in the development of the society determine the new requirements related to the educational models of the 21st century. They impose the use both of the traditional, classic ways and the modern methods and procedures in that respect. Word goes mainly about the *interactive* or *active* models of education as an up to date model of successful education. They are reasoned on the shared experience of the educated students /athletes/. We are paying special attention to the possibilities of the interactive methods for stimulating and developing certain personal manifestations, basic requirements about the interactivity within the group, class, team as well as the interactive methods most often used in the educational /sports/ activity. *The basic methods* on which the present development is reasoned are – studying literature sources, concrete investigations on the problem as well as official state documents – laws, ordinances, decrees. *The results,* the issue take to the front the necessity of a systematic and permanent increase of the pedagogical competence of teachers and coaches by entering them into organized systems and forms of training, i.e. exercising, training in contacts and mutual activity.

Key words*:* education, interactive methods, effects, interactions, competences, training.

INTRODUCTION

It is known that the concept of education is one of the oldest and most often used within the education and upbringing process. It appears as a deliberate form for acquiring knowledge during the earliest stages of the human family development yet. It is of permanent or uninterrupted primary function of the development both of men and the society. It is difficult to imagine the pass on and the use of the social experience, the human values and samples without the organized education. It is a confirmed understanding that education is a conscious, purposeful, specially organized and managed by the teacher /coach/ process for learning by those taught /trained/ of a system of knowledge as: facts, concepts, hypothesis, theories, laws, rules, models of behavior, establishment of skills, habits, relationships, qualities important for the personality, development and manifestation of abilities, as well as formation of values, attitudes, motivation and expectations.

Within the standards approving the new requirements of the society towards the educational process special attention is paid to the issue related to the contents and organization of the education; they are systemized in the following basic directions:

- Orientation to the *understanding* and *comprehension* of knowledge;
- Limitation of the *reproductive knowledge* role*;*
- Stimulation of the *creative activity* of the students;
- Unification or equalization of the requirements when *the specific individuality* of those taught is fully recorded.

That takes to the front the issue about the new role of the student within the educational process as well as the specificity of the "relation" within the teacher-student, coach-athlete system.

The modern requirements to the education within the dynamically changing world are related mainly to:

- *study* related to knowledge and understanding for receiving general culture and deep knowledge;
- *study* related to mastering a concrete activity for acquiring competence, qualification and readiness for successful coping in various situations;
- *study* related to the formation of skills of full value about living together and understanding;

- *study* related to "surviving" and personal development.

As far as sports education is concerned, the down mentioned items can be added to those four basic "pillars":

- *study* related to objective knowledge about "oneself" in two possible directions: the first relates to acquiring knowledge about "oneself" as a personality, "recording" one owns' positive and negative characteristics, the strong and weak sides of the character; the second relates to the formation of skills and qualities about "competent" and "purposeful" self analysis, for finding the own "I", the own professional and human "worth and faults";
- *study* related to the formation of a position of incessant seeking, finding and creating;
- *study* related to finding a new knowledge, new factors and suppositions determining the sports success and the high sports results;
- *study* related to mastering the moral, goodness and beauty inherent for sport.

Indisputable is the fact that the effectiveness of the education depends to the greatest degree on the *methods of education.* The key words for giving a definition to the concept of "method" most often are decreased to – "way", "manner", "procedure" for realizing the purposes and tasks of the education. The specificity of the sports education methods is a function of at least three basic provisions: characteristics of the sports discipline, purpose and tasks of the preparation, age and individual particularities of those practicing sport.

Within the context of the modern requirements to the educational models of the 21st century, primary importance acquires the issue about the *interactive* or *active* methods of education. They are based on the active and purposeful influence and interaction between the subjects participating in the mutual activity: teaching-taught, between the taught themselves and taught-group. The teacher and the student are equally important subjects in this process. In short, word goes about the interaction between all participants in a given educational /sport/ group as well as the team work. The purpose is a possible mutual "influence" and personal enrichment, increase of the knowledge, formation of the necessary motive skills, habits and relations, possible changes in the views of the separate participants on various issues, problems and events, expectations and personal behavior within the process.

The interactive methods take to the front the requirement for mutual solution of the problems, not taking in mine who of the participants has given the idea. The effective education is based on the shared experience of those teaching and those taught. That is in fact the essence of the humane, democratic approach to the education within the new conditions and realities.

It has been proved that the interactive methods have richer possibilities for stimulating and developing of:

- the creative activity and workability of the individual according to his/her interests, inclinations, abilities and expectations;
- independent acquisition of knowledge according to the specificity of the individual intellectual and physical development as well as skills for the formation of collective relationships;
- motivation for high school and sport results and achievements;
- striving for independent seeking of solutions to arising problems in expectant and non expectant or spontaneously arisen situations;
- skills for team work and understanding about the inter dependence at higher "autonomy" or independence;
- creative and "innovative" thinking;
- self conscience, self awareness and self achievement;
- striving to self development, self perfection and successful professional and personal realization;
- becoming well acquainted and understanding "foreign" views, ideas, understanding, positions and their interrelation to the "oneself";
- taking own's decisions on the base of shared experience;
- the cognitive, civil and personal particularities of the taught students /athletes/;
- the abilities for self informing, inner confidence, criticism and argumentation;
- the self control and the self evaluation;
- the ability to observe, analyze, discuss the current processes and events and taking decisions;
- the manifestation of understanding and compassion for the "other", responsibility and leadership;
- the mastering of intellectual, socio-cultural models of behavior.

The effectiveness of the interactive education takes to the front the issue related to the interactivity *requirements* within mutual work in the group, team. The basic of them are as follows:

- clear formulation of the target and the tasks of the concrete activity or occupation;
- recording the interest of the group towards the concrete occupation;
- the activity of the participating objects in the mutual activity;
- respecting the view of every participant in the process;
- providing possibility for the participants to observe, analyze, discuss;
- cooperation, good will, mutual respect, support and responsibility;
- openness and interest in establishing the truth;
- observing the regulations and rules of the group activity;
- creativeness, non standard, originality, fantasy, flexibility of mins and behavior, etc.

The pedagogical theory and practice speak that the *interactive methods* of education most often used, are as follows:

- *The dialogue* which most often is called "heuristic"conversation or "question-answer" method for finding and mastering new knowledge, truths, evidences, establishment of cause and effect relationship and dependence for the successful execution of certain actions. The aim is to achieve the necessary, wished and expected school and sports results.
- *The discussion* is "peculiar", "free exchange" of views, ideas, positions, concepts, on certain thesis or problem. It covers elements of "mutual information", "attack" on disputable thesis, positions, conceptions. It is directed to mastering information and experience about independent and creative solution of arisen problems, which requires originality and alternatives. In most of the cases the discussion has got uniting emotional function and cognitive effect related to the complexity of the separate elements of the school and sports activity.
- *Dispute* or consideration of unsolved, actual and important questions and taking the necessary decisions. It is used to format "base" positions and getting knowledge about primary views on the discussed matters. *Обсъждането* или разискването по нерешени, актуални и значими въпроси и вземане на необходими решения. Предназначено е за формиране на „базови" позиции и опознаване на първоначални мнения по обсъждани проблеми.
- *Polemics* most often is related to "opposition", "confrontation", with emotional and "biased" stand up of positions. It hides rich possibilities for getting knowledge of "someone else's" or "others" views on the problem.
- *Debates* are related to an exchange of ideas, presentation of positions, arguments "in favour or against" certain view, decision, problem. They are managed by an expert. Discussion is taking place till all presented arguments are exhausted and on those base decisions are taken.
- *Case study* for analyzing information, taking basic issues to the front, choosing alternative variants for decisions and behaviour, taking the correct decision in concrete sport-pedagogical situation of specific and unique characteristics.
- *Complicated case method* where the taught are exercised in taking decisions about unexpected or spontaneously arising problems in certain situation. In this case there is not a single correct decision but a possibility for variety of decisions. The complicated cases most often used are usually those where expedient decisions are taken with concrete examples of the school /sports/ practice and events, presented by video techniques.
- *Game* methods are interesting and attractive. They are applied for all age groups and types of lessons or training sessions as well as in the various stages of the sports education. Their functions are mainly didactic – certain way of performing motive actions; lasting mastering of knowledge, skills and their application in the practice; activation of thinking and imagination; development of the feelings and initiative; originality of the decisions and creative manifestation. They attribute to the communicative skills and abilities, sensitivity, striving to an active cooperation and interaction, etc. Most often used are the businesslike, role-like and imitation-like games.

CONCLUSION

As a *conclusion* we are going to point out that universal methods of education which indisputably can be used in the sports-pedagogic practice do not exist. The approved methods mentioned hereinabove have got their optimal parameters of application, advantages and defects. That is the reason why a complex of methods in applied in modern education. Not less important, according to us, is as well the issue of the pedagogical competences of the teacher /coach/ about the effective pedagogical interaction, established on the ground of humanism, collaboration, mutual respect, confidence and responsibility..

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DEVELOPMENTAL COORDINATION DISORDER ON THE PHYSICAL EDUCATION CLASS

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SUMMARY

Developmental coordination disorder (DCD) is a motor disorder that is notices among children in early school age. It covers a wide range of symptoms that are manifested through the motor, social-emotional aspect and academic achievement, which classifies it under a serious developmental disorder. For this reason there is a need for its early identification as that is the best way to prevent the occurrence of secondary changes. The physical education teacher has a significant role in the identification process of this developmental disorder. DCD does not stop with the growth of the child wherefore it is an important application of appropriate programs or effective interventions. The approach to this problem during the gym class could be various, thus the contents which are used as a tool. All applied approaches have aim to facilitate the daily activities of children, and thereby improve their quality of life.

Keywords: physical education teacher, school, PE class

INTRODUCTION

An important milestone in the life of every child is the inclusion in educational institutions. When children start the kindergarten and school they should be capable to demonstrate a certain level of various abilities and skills in order to successfully adapt to the new requirements and responsibilities. However, it is not so rare that problems which are often caused by developmental disorders that limit the successful functioning of the child are becoming clearly visible. In the group of frequent developmental disorders could be included difficulties in motor functioning, which occur to healthy children. The manifestation of a wide range of motor difficulties caused the significant terminological inconsistency, so as synonyms for this disorder occur: a clumsy child syndrome, dyspraxia, perceptual-motor dysfunction, motor function, delayed motor development (Henderson & Barnett, 1998). On the international meeting of researchers and medical professionals in London in 1994 as the most appropriate term for this disorder was determined to be developmental coordination disorder (DCD).

Developmental coordination disorder is a motor disorder that occurs in children and affects their daily activities (APA, 2000). The etiology of this disorder is still not well known and imprecise, but according to research certainly multifactorial. The most studied factors in the literature are: brain damage, genetic predisposition, damage mechanisms for information processing, a bad environment for the development of motion experiences (Missiuna & Pollock, 2011). In atypical development, motor abnormalities are associated with dysfunction of the cerebellum, thus it is considered as one of the causes of this disorder (Ivry, 2003). From the aspect of the motor control cerebellum is involved in the synergistic organization. Synergy is the main biological mechanism that controls a large number of elements with a relative small number of commands (Latash, 2008). This mechanism simplifies performing tasks that require the involvement of a large number of muscles and joints, which are often present in daily activities. If this mechanism is not functional, there is a great difficulties with daily activities, which is the main characteristic of children with this disorder.

Presence of this disorder according to the American Psychiatric Association (2000) includes 5-6% of school children, including potentially one child in the class. Most studies show that the DCD syndrome affected more boys than girls, and their relationship generally varies from 2:1 to 5:1, depending on the identification method.

Teacher of physical education plays an important role in identifying children who have DCD. Everyday work with children in classes where he monitors their motor development and skills allows the teacher to easily recognize the typical characteristics of DCD syndrome. Beside early identification teacher can also affect disorder through physical exercise and in that way facilitate the performance of their daily activities, and thus preventing secondary effects.

The subject of this paper is to get more familiar with developmental coordination disorder from the perspective of physical education teachers. The first aim is to determine the typical DCD symptoms, the second is to present the most practical tests for the diagnosis and the last is to show programs that have proved to be effective and can be applied in gym class.

IDENTTIFYING DCD SYNDROME IN SCHOOL

Motor disorder

Developmental coordination disorder is accompanied by poor coordination and the so-called "clumsiness" during execution of the movement. Problems with coordination can be manifested in many diverse ways, ranging from unskilled writing and drawing, clumsiness in the daily games, difficulty in buttoning buttons, using scissors, etc. Authors Polatajko and Cantin (2005) have classified problematic activities depending on the environment. In home conditions, children with this disorder have problem with dressing, bathing and putting on shoes, while at school they have problem with writing, "drawing immature", frequent falling from the chair and colliding with things and peers. In playgrounds these children can be easily seen because of odd running, skipping the low objects and rope, because of the poor catching, throwing and kicking the ball, and the unsuccessful rollerblading and riding a bicycle.

This disorder is characterized by problems in fine motor skills (manual dexterity), and in locomotion of the whole body, or those that occur in their combination (Missiuna et al., 2004). Most difficulties children have with activities that require constant change of posture and adaptation to variable external conditions. These problems could occur because children have problems with postural control, which comes to the fore when standing on one leg (Geuze, 2005). Children with DCD avoid games with peers and prefer individual activities (Missiuna & Pollock, 2011). In accuracy tests they show lower level of accuracy in relation to their peers (Smits-Engelsman et al. 2003). When they perform fast movements it can be noticed an increased level of coactivation of agonist-antagonist, which also characterized people with other motor disorders (Latash, 2008). All motor characteristics that follow this disorder lead to disturbances in motor learning, which is manifested in difficult learning of the new movements, planning movement and adaptation to new changes.

Socio-emotional characteristics and academic achievement

In addition to changes in perceptual-motor skills, developmental coordination disorder is also followed by secondary changes. Since children with this disorder can not successfully master basic motor movements, they become frustrated and stop seeking solutions to motor tasks. So this disorder is accompanied by decreased socialization, as well as occurrence of emotional (frustration, poor tolerance, unhappiness, lack of motivation, depression) and obesity (Dewey et al., 2002; Cairney et al., 2005; Missiuna & Pollock, 2011). In children with DCD slowness, laziness, apathy and lack of interest in physical activity can be noticed(Gauze, 2005). Sometimes these problems occurs together with problems in attention, learning, writing, spelling, organizing tables, cabinets, home tasks, and all of that can affect their academic achievement (Dewey et al., 2002). Children with this disorder often have other developmental disorders such as dyslexia, hyperactivity disorder and speech difficulties. The interaction of these disorders with DCD syndrome may affect the diagnosis and their future prognosis.

It may be noted that the developmental coordination disorder leads to a string of chain disorders. It represents much more than the inability to perform daily activities, wherefore there is a need for its early to identification, and that is not possible before the age of five. Thus, 25% of children can be identified in the preschool age, while 75% of them in the first years of schooling (Gibbs et al., 2007). This disorder is usually confirmed by the pediatricians, and in the process of identification key role have physical education teacher or a regular teacher. The PE class is ideal for spotting all motor irregularities of one child.

DIAGNOSING DCD SYNDROME ON PHYSICAL EDUCATION CLASS

There is variety of tests that are used in practice for the diagnosis of DCD, and to determine the influence of the program on the ability of these children. Most of these tests can be successfully implemented in the gym for physical education by teachers. In the literature, the most mentioned standardized test is BOT-2 (Bruininks-Oseretsky Test of Motor Proficiency, Bruininks & Bruininks, 2005) and MABC battery of tests (Movement

Assessment Battery for Children, Henderson & Sugden, 1992). These tests are made to estimate motor skills of the subjects. In addition to these tests, there are questionnaires that allow obtaining a full image of this disorder. They are divided into groups depending on the subjects in which they refer to, so there are questionnaires created for parents (DCD-Q), teachers (Checklist-movement ABC, Movement observation Questionnaire for teachers) and children (Perceived competence scale, The Pictorial Scale of Perceived Competence and Social Acceptance for Young Children).

The most commonly used standardized battery of motor tests is MABC. It is a valid and reliable method, in the literature also called "gold standard" for identifying developmental disorders of coordination (Venetsanou et al., 2011). This test can diagnose the disorder and monitor the impact of the program for children aged 3 to 16 years. These tests are classified according to age group, from 3 to 6 years, 7 to 10 years and 11 to 16 years. MABC battery test consist of three different groups of tests: the manual dexterity tests, tests with the ball and balance tests. Selection of the tests depends on the age, namely becoming more complex to suit the given age groups. Each test is evaluated with grade of 0 (success) to 5 (failure), so in the end the total score of all the tests is from 0 to 40, where at the same time less number is a better result, and vice versa. These results are than compared on the basis of age with existing norms of test. According to the existing norms, if the respondent belongs to the group below 5 percentile, developmental coordination disorder has been identified, and if the results are between 6 and 15 percentile, there is a potential risk that the disorder is present (Henderson & Sugden, 1992).

Since DCD syndrome is a complex disorder, during identification motor characteristics and psycho-social condition of children should be assessed in addition. The choice of tests depends on the age, more precisely the maturity of the child. For ages 4 to 7 years, it can be applied a standardized test based on images for the assessment of self-confidence and social occurrence (Harter & Pike, 1984), and for ages over 8 years scale for assessment of self-confidence (Harter, 1982).

Based on the children's opinions, their confidence is evaluated, through the following four aspects: cognitive, social, physical and general self-confidence. The cognitive aspect consists of perceived academic achievement of children, their success in school, and satisfaction by their knowledge and performance in class. The social component represents the child's sociability, popularity, while the physical component measures how much a child loves sports and what he thinks about he’s success in sports. The general component exists at eight years and older children, and estimates the satisfaction of the child himself. It is considered that children of younger ages are unable to assess satisfaction with themselves, so general self-confidence is cautiously estimated based on the remaining components. The test to be applied to younger children consists of paintings, where the examinees choose the one that describes them more in a given situation, while in ages from 8 years interviewee chooses between the two statements.

The main approaches and programs that can be used in PE class

DCD syndrome does not end with the child's growing up, wherefore the corresponding application program is important or effective intervention in order to avoid negative impacts that DCD syndrome brings. Table 1 presents the main approaches that can solve the problems of this disorder. In the literature, the two most prominent approaches stand out, process-oriented and task-oriented approach. In process-oriented programs, the goal is to influence the processes that are responsible for the execution of movement, as opposed to task-oriented programs where the focus is on the result (Peters & Wright, 1999) or directly on the functional skills (Schoemaker et al ., 2003).

Table 1. The main intervention approach to developmental coordination disorder (Geuze, 2007).

The outcome	A content perspective	Approaches
1. Reduction of functional or structural disorders	Deficit oriented	Sensory integration Sensorimotor approach Oriented processes
2. Increase of activity and participation	Performance-oriented	Task-oriented Cognitive approach

In the first approach, attention focuses on those processes that are not developed for a specific age (deficit oriented), and which are essential for the successful execution and the acquisition of motor skills. Such processes include sensory functions (vision and perception), memory, attention, planning and creation of motor programs (Sudgen & Chambers, 2003). This approach is based on the assumption that it is impossible to treat all of their daily activities, but it is possible to treat some of the sensory nerve areas and then transfer is performed on the other skills. The logic of this approach is that if the deficit persists, benefit will show up in daily activities that are under the influence of these processes (Sugden, 2007). One of the examples of programs that are oriented to the processes of sensory integration (SIT - Sensory Integration Therapy), is based on the assumption that children that have some developmental disorders, have a deficit in the integration of perceptual information. Treatment in this program is characterized by stimulation of sensory systems (vision, hearing, touch, etc.), so that the integration of sensory information in order to obtain adequate motor response is encouraged in children. This method is most popular among physiotherapists and occupational therapists, however, there is not much evidence to support the effectiveness of processes-oriented programs (Schoemaker et al., 2003). Programs belonging to this approach stimulate specific structural area of the brain, especially the cerebellum, which is important for motor learning. Since the DCD syndrome occurs in combination with other disorders (dyslexia, hyperactivity disorder), it is difficult to distinguish the effects which these programs produce (Sugden, 2007).

The perspective that is focused on the effect has two important approaches: tasks-oriented and cognitive approach.

Over the past decade, considerable amount of research in this area was based on the tasks-oriented programs. Although relatively new, the resulting effects are promising. This approach has a number of programs, which are based on the learning of those tasks which are for some reason badly executed, or on the technique of performing daily activities (Sugden, 2007). One of these programs is Neuromotor training task (NTT) originating from the Netherlands. It is based on the advantages and weaknesses of children's functional performance, where the therapist first analyzes what are the cognitive and motor processes that have led to a deficit of motor performance. After that, specific content in various conditions and with various objects is applied, thereby creating a positive and relaxing environment which contributes to improving performance.

Cognitive approach was very present in the early nineties, and some of the most common programs are verbal guidance, cognitive orientation to daily occupational performance (COOP) and the parent-teacher intervention program (PTIP).

The concept of the program depends on the different theoretical views addressing these objectives, experience, knowledge and work of therapists and teachers. In practice, it often happens that therapists combine multiple elements or programs into one (Sugden & Chambers, 2003).

Reviewing the literature showed that there are various programs that are used in order to assist and facilitate the daily activities of children with DCD syndrome, and thus prevent the occurrence of secondary effects. In a review study, which included papers from 1997 to 2004, over 30 different programs were recorded, and as the most commonly used program stands out sensory - motor program (Hillier, 2007). The program content is adjusted to age, individual characteristics of children gender and of course purpose. Hillier (2007) in his review study points out that the betterment was recorded in all tested interventions, and thus it is noted that in developmental coordination disorder is better to apply any of the interventions than none. The programs are applying various contents as a tool. Some of them use the "verbal therapy" where children verbally lead themselves to the solution of specific tasks, the music that aligns with exercises, visual training, various sports activities, exercise at home, virtual games with the use of computers, as well as mastering tasks in cooperation with parents and teachers.

The good side of all mentioned programs is that they can easily be applied to physical education classes. They can be an integral part of the school program, and depending on the number of children who have a greater or lesser manifestation of this disorder, classes can be organized (collectively or individually). The implementation of these programs can be an integral part of the main class or some form of supplementary or remedial classes.

In addition to existing programs, a key role is played by the knowledge of existing principles by teachers working with children, of so-called M.A.T.C.H. strategy (Missiuna et al., 2004). It was developed by the authors that deal with practical principles, with which teachers can modify actions and adapt their expectations. Basic principles that underpin this strategy are as follows: modify tasks, adjust expectations and learning strategy, change the environment and help in better understanding. These principles allow the activities to be adjusted to the abilities of children, and they can be applied in the classroom, but also in the area of physical education.

Physical activities that are difficult for a child with developmental coordination disorder should be modified to the extent that the child can succeed with the efforts. On the basis of a main goal, the teacher can flexibly modify the physical activity. Children with this disorder may have the same capacity to learn as their peers, but they require a different approach. The environment as an integral part of physical activity, may affect the ability to perform certain activities, so the change of particular external factors that interfere the performance of motor behavior can improve performance itself. Knowing the nature of this disorder will enable teachers of physical education a better approach to work with these children, and with offering understanding and support they will encourage and engage children in new activities. In this way one can achieve progress in its skills, strengthen self-esteem and promote the value of physical activity for a long time. Promoting fun, effort and participation should be in the first place in relation to the improvement of skills (Missiuna et al., 2004). Activities of children that are not competitive, but rather emphasize their own abilities and performance can be beneficial. When learning a new activity, children with this disorder may be demonstrators, but with the help of teachers who give them instructions, so that in addition to visual information they can directly experience the movement. For activities that require manipulation of the balls modified props should be used (e.g. lighter balls), and thus reduce the chance of injury and increase the efficiency of performance. Missiuna et al. (2011) recommended that the first choice of children with DCD syndrome should be activities in which external conditions of environment do not change too much (running on the track, skiing, swimming and cycling). Beside these general conclusions it should be noted that each child has aforementioned characteristics to the different extent, while some do not at all. Creating a curriculum for children with DCD syndrome should be modified to the individual characteristics of each child, wherefore it occurs after the mentioned diagnostic tests.

CONCLUSION

Developmental coordination disorder is present in a large number of school children. Based on the literature review, a wide range of symptoms that includes motor, social-emotional area and academic status is noted, which classifies it in a serious developmental disorder. Early identification is crucial in the treatment of this disorder, because it is the best way to prevent secondary changes. Therefore, education of personnel in the educational system is of a great importance.

The interaction between the child, parents and teachers is connection without which is impossible to start any kind of progress. However, when a child's development is followed by a disorder, in addition to well-established connections child-parent-teacher, professional help of qualified persons is also needed to overcome limits and develop a motor-cognitive potential of the child. Since this disorder is primarily evident through locomotion of the child, the role of physical education teachers is very important. Programs that efficiently serve to reduce the symptoms of developmental coordination disorder could be successfully implemented within school hours. Every type of intervention that was applied in previous researches proved to be successful, so it can be concluded that the various programs may facilitate the daily activities of children and therefore improve their quality of life. Efficient programs could also be applied in other institutions dealing with this issue.

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THE IMPACT OF FUNCTIONAL TRAINING METHOD ON THE DEVELOPMENT OF REPETITIVE BODY MUSCLE STREGTH WITH THE SEVENTH GRADE PRIMARY SCHOOL PUPILS

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SUMMARY

Strength as a motor ability is developed in parallel with other motor abilities at Physical Education classes. We are not able to apply the methodology and the laws of strength development relevant for sports to Physical Education classes. Therefore, it is very important to find adequate contemporary methods for strength development at Physical Education classes. Nowadays, the most frequently used method in classes where the strength of body musculature is being developed is the method of dynamic repetitions. Working with these parallel groups of seventh grade pupils we wanted to show the influence of Functional method and its advantages and benefits in body musculature strength development comparing to the formerly used methods. The experimental group was systematically subjected to the experimental Functional method of physical strength development. The control group was subjected to the dynamic method – repeated strains (the development of repetitive physical strength). At the initial and final measuring the pupils were tested by the elements of Eurofit battery and IPFT test. The progress we made after four-month-research in motor variables with the seventh grade pupils of primary school can be completely attributed to the use of the experimental functional training method in Physical Education classes.

Keywords: Physical Education, physical development, muscle strength, comparative testing.

INTRODUCTION

Strength is the basic physical ability indispensable for each movement. It is ability to overcome the outside resistance using muscular contractions or to oppose that very same resistance. According to Barrow, & McGee (1975) physical strength is the ability of an individual to create muscle force.

We are not able to apply the methodology and the laws of strength development relevant for sports to Physical Education classes. We can apply only certain rules – strength exercises aimed at overcoming the resistance of the weight of one's own body or certain parts of the body are most frequently used.

There are a few methods for physical strength development:

- Overcoming non-maximum resistance with the maximum number of repetitions (dynamic method)
- Overcoming the maximum resistance in static or dynamic regimes
- Overcoming resistance with maximum speed
- plyometric method (it uses eccentric contractions for physical strength development),

By applying the method of dynamic exertion, the maximum strength is reached and small and medium intensity resistance is overcome with the maximum speed. This method is applied with school age children and is usually combined with other methods such as the method of repeating resistance and the method of maximum resistance, which causes the increase in absolute strength. This method involves a great number of motor units working synchronically and the frequency of the impulses reaching the muscles is at its maximum.

At this stage of life, children are in a prepubertal phase which many psychologists (Kapor-Stanulović, 2007; Smiljanjić, 2009) call a stationary phase in a child's development. For that reason, this age is very suitable for the use of experimental method because the growth of almost all motoric abilities can be influenced by the external stimuli.

The primary cause of this experimental research is to verify the possibility and appropriateness of the use of functional training method in physical strength development with the seventh grade primary school children and its effects in the process of Physical Education teaching. The functional training method was taken from physical medicine and physical therapy. By means of this method a patient functionally recovers a lot faster than by applying earlier methods. It is also characterized by pretty large engagement of proprioceptors (Norris, 2003; Grey, 2013).

Apart from the superficial trunk muscles which are active while performing exercises, the functional training method activates proprioceptors which then activate deep layers of muscles and joint connections. The movements are multidimensional and are frequently made in two or three planes (frontal, sagittal and vertical). In the majority of applied exercises, the abdominal muscles and the muscles of the back maintain the position of the body and they are in the constant isometric work regime. Gray (2013) calls these exercises 2D or 3D exercises.

In physical education and sports this method is used for deep muscles-stabilizers (functional muscles) development. The functional training method activates proprioceptors which then activate deep layers of muscles and joint connections. The method is also very efficient in injury prevention and rehabilitation, Cook (1997), McGill (2002a, 2002b, 2002c) and Boyle (2003, 2004).

METHODS

The research was of an experimental type and it lasted one school half-term, from February 1st to May 31st 2014.

Subject sample

The subject sample consisted of the seventh grade primary school children divided into an experimental and a control group. The experimental group numbered 100 pupils and the control group 86 pupils. The experimental group was systematically subjected to the functional method of physical strength development. The control group was subjected to the dynamic method - repeated strains (the development of repetitive physical strength).

Measures and Procedures

We followed the changes in the following morphological variables:

- body height,
- body weight,
- BMI - Body Mass Index (Heyward, & Stolarczyk, 1996; American College of Sports Medicine, 2006).

We also followed the changes in the following motor variables:

- test of repetitive abdominal musculature strength,
- test of repetitive back musculature strength,
- test of repetitive chest and shoulder strength and arm extension strength test of repetitive chest and shoulder strength and arm extension strength.

At the initial and final measuring the pupils were tested by the elements of Eurofit battery (Council of Europe, Committee for the Development of Sport, 1988) and IPFT test (International Physical Fitness Test):

- Sit-Ups in 30 seconds (test of repetitive abdominal musculature strength),
- PRC - DTE - test (test of repetitive back musculature strength), according to Burns, Hannon, Saint-Maurice & Welk (2014),
- push-ups on a chair in 30 seconds (test of repetitive chest and shoulder strength and arm extension strength).

This is the example of a weekly exercises program for the experimental group:

1. support on forearms,
2. support on a ball or a medicine ball or a sideway bridge,
3. lying on the back children touch their soles lifting shoulder blades and legs bent in hips and knees,
4. deadlifting with a ball on one leg,
5. lifting to a position of a bridge on the shoulder blades with a "redondo" ball between the knees,
6. trunk twist with a medicine ball.

All the exercises were done in two series lasting 30 - 45 sec each. These two pictures below show the essence of the exercises.

This is the example of a weekly exercises program for the control group:

1. sit-ups to the angle of 45 degrees,
2. extended lifting of the opposite leg and arm while lying on the stomach,
3. back hyperextension with the palms on the floor imitating breaststroke swimming with the chest lifted from the floor,
4. lifting the ball with extended arms to a forehead level while standing,
5. push-up on a bench or Swedish ladder,
6. sideway arms lifting from the position of arms extended to the level of shoulders to the positon of arms above the head (sideway arms lifting).

The exercises were done in three series of 15-20 repetitions at the same lesson stage as in the experimental group.

Statistical analysis

The data obtained during the study were analyzed using descriptive and comparative statistics. As for the descriptive statistics, we used the following representative and dispersion parameters to analyze each variable:

- the distribution of frequencies,
- mean,
- standard deviation and variance,
- standard error of the mean,
- variation width - minimum and maximum,
- measuring normality schedule - Skewness & Kurtosis.

From the area of comparative statistics, we used discriminant analysis by which we tested the differences among the mean values between groups and within them, as follows:

- t-test for independent samples - when testing the significance of differences between the average results of the experimental and control groups received at the initial and final measurement for each variable,
- t-test for dependent samples - when testing significance between the average results obtained at the initial and final measurement for each variable, separately for control and separately for the experimental group,
- analysis of variance - F test.

Both discriminant procedures were carried out in the process of analysis of covariation (ANCOVA).

RESULTS

The tables below show the research results.

Table 1. Descriptive statistics at the final measurement for both groups of the seventh grade pupils

Variables	Groups							
	Control (N = 86)				Experimental (N = 100)			
	M	SD	Min	Max	M	SD	Min	Max
Body height	169.17	±6.59	156.00	191.00	167.21	±7.69	152.00	191.00
Body weight	57.55	±8.68	41.10	73.00	55.41	±10.88	34.50	93.00
BMI	20.03	±2.17	14.04	25.09	19.65	±2.43	13.82	25.49
Repetitive strength of abdominal musculature	24.70	±3.80	16.00	36.00	29.11	±5.53	15.00	42.00
Repetitive strength of back musculature	19.86	±5.20	25.00	56.00	24.80	±5.86	9.00	33.00
Repetitive strength of arms and shoulders	16.52	±2.96	8.00	23.00	18.94	±3.18	11.00	28.00

Legend: BMI - body mass index; M - Mean - arithmetic mean; SD - standard deviation; Min. - Minimum value; Max. - Maximum value.

Table 2. The results of t-test for independent samples used for the final measuring of both groups of seventh grade pupils

Variables	t	p
Body height	1.875	0.062*
Body weight	1.485	0.139**
BMI	1.132	0.259**
Repetitive abdominal musculature strength	-6.414	0.000*
Repetitive back musculature strength	-6.082	0.000*
Repetitive strength of arms and shoulders	-5.366	0.000*

Legend: t - t-test value; p - level of significance; *p<0.05; **p<0.01.

Table 3. T-test for dependent samples - establishing the importance of differences in arithmetic means at the initial and final measuring in control group (N=86; df=85)

Variables	t	p
Body height	-19.610	0.000*
Body weight	-2.772	0.007
BMI	-.247	0.805
Repetitive abdominal musculature strength	-13.718	0.000*
Repetitive back musculature strength	-4.862	0.000*
Repetitive strength of arms and shoulders	-7.995	0.000*

Legend: t - t-test value; p - level of significance; *p<0.01.

Table 4. T-test for dependent samples - establishing the importance of arithmetic means differences at the initial and final measuring in experimental group (N = 100; df = 99)

Variables	t	p
Body height	-14.491	0.000*
Body weight	-12.131	0.000*
BMI	1.899	0.060*
Repetitive abdominal musculature strength	-15.439	0.000*
Repetitive back musculature strength	-12.490	0.000*
Repetitive strength of arms and shoulders	-17.987	0.000*

Legend: t - t-test value; p - level of significance; *p<0.01.

When the final results of the measuring of pupils (experimental group N=100 and control N=86) are compared, after four months of research (one term) and the obtained results, we can conclude that t-test for independent samples (Table 1 and 2) showed statistically significant differences in variables:

- *Body height* - the seventh grade pupils in the control group were approximately taller (M = 169.17; SD = ± 6.59) compared to the experimental group pupils (M = 167.21; SD = ± 7.69) - t = 1.875; p<0.06 at the final measuring.
- *Body weight* - the seventh grade pupils in the control group were approximately heavier (M =57.55; SD = ±8.68) compared to the experimental group pupils (M =55.41; SD = ±10.88) - t = 1.485; p<0.13 at the final measuring.
- *BMI* - the seventh grade pupils in the experimental group had approximately better score (M =19.65 ; SD = ± 2.43) - t = 1.132; p<0. 259 compared to the control group pupils (M = 20.03; SD = ± 2.17) at the final measuring.
- *Repetitive abdominal musculature strength* - the seventh grade pupils in the experimental group had approximately betters results (M =29.11; SD ±5.53) - t=-6.414; p<0.01 compared to the seventh grade pupils in experimental group (M =24.70 ; SD = ±3.80) at the final measuring which we can consider a result of the applied experimental functional training method.
- *Repetitive back musculature strength* - the seventh grade pupils in experimental group had approximately better score (M = 24.80; SD = ± 5.86) - t = -6.178; p<0.01 compared to the seventh grade pupils in control group (M =19.86; SD = ± 5.20) at the final measuring. We can notice the advantage of the applied

experimental functional training method in this motor variable too comparing to the programs for strength development used before with the children of this age.

- *Repetitive strength of arms and shoulders* - the seventh grade pupils in experimental group had approximately betters score (M = 18.94; SD = ± 3.18) – t = -5.366; p<0.01 compared to the seventh grade pupils in control group (M = 16.52; SD = ± 2.96) at the final measuring. We can consider a result of the applied experimental functional training method.

DISCUSSION

The success that we have made after four-month-research in all motor variables with the seventh grade pupils of primary school – Repetitive abdominal musculature strength (t= -6.414; p<0.01), Repetitive back musculature strength (t = -6.178; p<0.01) and Repetitive strength of arms and shoulder (t = -5.366; p<0.01) – can be completely attributed to the use of the experimental functional training method in physical education classes. The results of t-test for independent samples used for the final measuring of both groups of seventh grade boys confirm this progress. During the four-month-period of the experiment, the experimental group pupils made bigger progress in repetitive strength development than the control group pupils although the progress in strength is visible in pupils of both groups (Tables 3 and 4).

Experimetal training method can be used in every class, regardless of the planned unit thus contributing the continuous physical strength development with the children. Former exercise methods demand a special organization (particular devices, props.), which leads to much less time devoted to the main part of the class. In this way, children are not able to acquire the necessary skills and knowledge (Višnjić. Jovanović. & Miletić. 2004).

The development of physical strength with primary school children is necessary for their growth and development (Kukolj, Jovanović & Ropret, 1996). Body muscles power has a very important role in child's growing process because deep muscles enable correct posture and decrease the possibility of spine deformities. Functional training method in physical strength development is based on abdominal and back musculature strength development (Cook, 2010). Unlike the classic methods of physical strength development, this training method creates the same or even better results in physical strength development for the same period of time (Višnjić, Marković & Ilić, 2012).

The applied exercises are easy for pupils as well as for teachers (trainers) who control them. The teacher (trainer) does not have to provide the rhythm. Pupils (sportsmen) perform the exercises at their own suitable pace. The errors in performing are easily and quickly removed. The exercises are done in periods lasting from 35 to 40 sec at the beginning. Later, the time for doing the exercises can be prolonged (Liebenson, 2014).

Unlike classic methods for muscle power development, functional training method consists of three types of muscular contractions (static, excentric and concentric) (Boyle, 2010). Former methods for physical strength development are based on concentric muscle contractions.

The exercises used in functional training method belong to a group of complex exercises because they engage more groups of muscles at the same time, which is very important for muscular groups surrounding child's spinal column. Performing exercises for abdominal musculature we simultaneously develop back and shoulder musculature.

The exercises can be easily and quickly modified (they can be made easier or more difficult) by changing the position of body parts or by shutting down one of the senses. If there have been changes in both groups (Tables 3 and 4), the differences in the variables of morphological characteristics, body height, body weight, body mass index (BMI) for the time being cannot be exclusively attributed to the influence of the experimental method, but they are a consequence of the natural growth and development.

In the former research, Markovic (2011) showed that functional method had better results on the physical strength development with the primary school children in the seventh grade. After the research, the experimental group had better results than the control group at the final measurement in the following measured variables: repetitive abdominal musculature strength (t = -3,974; p < .000), repetitive back musculature strength (t = -4,762; p < .000).

CONCLUSION

The importance of the research is reflected in finding more efficient, interesting and various contents – innovative methods in Physical Education classes in compulsory primary education. This implies the introduction of new programmes and methods aimed at developing all motor abilities, in this case strength developing methods.

New programmes and methods as well as innovations in general may motivate pupils to engage in physical activity and if by doing this they express themselves creatively, our class will definitely be successful.

The use of experimental "functional" method resulted in better effects in all variables with the pupils at this age. The differences in morphological variables (body height, body weight, body mass index (BMI)) cannot be attributed to the use of this method. They depend on the natural growth and development of individual pupils.

All above mentioned leads to the conclusion that functional training method used for physical strength development with the seventh grade primary school pupils gives better results than any other former method.

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THE INFLUENCE OF ELITE SPORT ON CHILDREN'S HEALTH

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SUMMARY

Children are the future for each country. That's way every effort should be made to ensure children's health. Is high performance sport a healthy pursuit? High sports mastery is achieved with multiple repetitions of each element and many, many hours training and this can be the reason for health problem. The purpose of this report is literature review for influence of elite sport on children's health. The goal of the literature review is to determine if there is evidence that high performance sport affects children's health. The existence of numerous studies for the relation between elite sports and children's health show actuality of the problem. Training or competitions can be the cause for delay in growth and sexual maturation, shorter stature; eating disorders, weight restriction, decreased body mass, hypoestrogenism, posture and spine deviations, low back pain and etc. There are great differences in the methodological procedures of different studies, defining the conditions and age of athletes and sports experience, these are just some of the problems which makes it impossible to determine the cause and effect of the relationship of sports and health fully, which is exactly the reason why there must be further controlled studies conducted that would establish or reject a link between a particular sport and health problems.

Keywords: children, health, high sport performance

INTRODUCTION

Is high performance sport a healthy pursuit?

Something can and must be done by all people who involved in training process to promote good children and adolescent health for the future generations!!!!

Elite athletes are who achieve, or who aspire to achieve, or who have been identified as having the potential to achieve, excellence in World Class competition. World Class competitions for high performance sport include the Olympic Games, Paralympic Games, World Championships, Commonwealth Games, and Pan American Games, among others (Bloom et al. 2006).

High performance sport is organized into The High Performance System comprised of those activities, programs, agencies, institutions and personnel that have as a primary objective the preparation and support of elite athletes. (Bennett, T. 2008)

High sports mastery is achieved with multiple repetitions of each element and many, many hours training.

Problems in elite sport as it get closer to the human performance limit. The Olympic motto, 'citius, altius, fortius' - faster, higher, stronger - gives a precise concentration of this idea. This paper discusses what may be the result as sport moves toward the limits of human performance.

Besides continuous and specific training, another feature of this sport is the early start - specialists in rhythmic gymnastics begin workouts with children in 4-5 years of age. Age in which all organs and systems are in continuous development and respectively carries risks of abnormalities in their anatomical and physiological features (most it applies to musculoskeletal and digestive system).

Children are the future for each country. If they are not in good health, do not develop well, do not have fun and are often ill, the country cannot be strong and prosperous. That's way every effort should be made to ensure children's health.

From birth to age 17 are performed some of the most interesting periods of postnatal ontogenesis. The child grows and develops, realizing as well as genetic talents and reflecting the specific conditions of life under which these processes are carried out (Nacheva et al. 2012).

Children's health and morbidity were always subject of discussion and observation of specialists, pediatricians and parents. The problem has existed for many years and experts never ceased to look for updates to the reasons and evolution as well as to their treatments, because for the best prognosis is important early diagnosis and timely treatment.

The Constitution of WHO (1946) states that good health is a state of complete physical, social and mental well-being, and not merely the absence of disease or infirmity. Health is a resource for everyday life, not the object of living, and is a positive concept emphasizing social and personal resources as well as physical capabilities. Health is a fundamental human right, recognized in the Universal Declaration of Human Rights (1948). It is also an essential component of development, vital to a nation's economic growth and internal stability (WHO).

PURPOSE

It is necessary to discuss health problems in elite sport nowadays as it gets closer to the human performance limit. There is not a single sport where athletes do not have a health problems, whereas the level and the type of disorder depend on the nature of the sport. This is why the goal of this article is to review scientific research papers on the subject of health problems in athletes so that we can perform an analysis of the conclusions obtained by other authors.

METHODS

This report is based on an extensive review of domestic and international accessible literature. It draws on refereed and non-refereed research findings, and incorporates both qualitative and quantitative research. This study examines the literature to summarizing the findings of these studies and to determine if there is evidence that high performance sport affects children's health.

Some of major domains of studies were 3 - 4 fields of healthy child development like emotional well-being (or mental health); cognitive abilities and school achievement (or academics); social skills and experiences (or social health).

The other major field of healthy child development - physical health, has been a focus of this review. During the growth it is significant important to look after and detect any deviation from the norms of physical development for appropriate age, in order to successfully take preventive measures and treatment.

As children are continuing to grow and develop both physically and cognitively, adults working with children need to have a basic understanding of child cognitive and physical development. It is also important to realize that at a given age, there is a wide range in terms of what is considered normal with respect to growth and development. Organized sports should match the developmental level of the participants, and include rules designed for health and safety. Demands of a sport or physical activity should not exceed the capacity of a child at their age and stage of development. When demands of a sport or physical activity go beyond a child's cognitive and physical development, negative health problem may result.

There has been a relative lack of focus in Bulgarian literature on how sport influences children physical health. There were few Bulgarian researches on the influence of sports on children`s health and effects of placed therapy (Zaharieva 2015, Zaharieva 2015a, Zaharieva 2015b, Zaharieva 2015c, Zaharieva&Gencheva 2014; Tanchev P. et al., 2000)

In international literature there are studies which explore few major field of health problem among athletes including posture alteration and spine deviation (Radaš, J., Trošt Bobić 2011; Kums T. et al. 2007; Bosso L, Golias A., 2012, Ashton-Miller 2004; Martinez, 2004), treatment methods and prevention of abnormal posture (Popa C., Dobrescu T., 2013), growth and sexual maturation (Malina RM, 1994; Claessens et al 1992), eating disorders, under nutrition, hypoestrogenism end etc.

Several investigations have compared age at menarche among female athletes participating in different sports with that of the general population. Delay in growth and sexual maturation is well documented among certain groups of elite female athletes, most notably gymnasts, dancers, and long-distance runners (Malina RM, 1994). Claessens et al (1992) found the median age at menarche to be 15.6 ± 2.1 y among a group of gymnasts and 13.2 ± 1.2 y among the control population. Theintz et al (1993) observed that among a group of gymnasts and swimmers aged 12.7 ± 1.1 y, only 7.4% of the gymnasts had experienced menarche, in contrast with 50% of the age-matched swimmers. The gymnasts in this study, however, had a significant delay in skeletal age (1.42 ± 0.99 y), but the swimmers had comparable chronologic and skeletal ages. Baxter-Jones et al (1994) reported the mean ages at menarche of adolescents being intensively trained in gymnastics, swimming, and tennis to be 14.3, 13.3, and 13.2 y, respectively, with a population reference value of 13.0 y. Significant delay was again noted only among the group of gymnasts. The data for gymnasts are replicated to a lesser degree in dancers and runners. Sports such as swimming, speed skating, and tennis appear to have minimal effects on growth or age at menarche (Malina RM, 1994; Malina RM, 1994a; Baxter-Jones ADG et al. 1994).

Investigations of growth parameters in adolescent female gymnasts consistently find these girls to be shorter and lighter and to have a significantly lower percentage of body fat than do age-matched control girls or athletes participating in less strenuous sports, such as swimming. Girls participating in the latter types of sports are generally taller and mature earlier than normal (Malina RM, 1994; Theintz et al 1993; Theintz et al 1994; Constantini NW, Warren MP 1995). Lindholm et al (1994) also observed slower growth velocities among a group of adolescent female gymnasts. Bernadot and Czerwinski (1991) observed all observe ages (7–10 y; 11–14 y) the gymnasts had significantly more muscle mass for their size than did the control group. Catch-up growth has been reported in gymnasts when their training is temporarily reduced or stopped (Theintz, 1994).

Worldwide, the single most common cause of growth retardation is malnutrition or under nutrition. Nutritional growth retardation (also known as nutritional dwarfism) and delayed pubertal development among elite athletics more often result from self-induced restriction of nutrient (energy) intake. Nutritional status also has a significant modulating effect on the timing of adolescent sexual development. Under nutrition is associated with later age at menarche (as well as secondary amenorrhea), whereas a moderate degree of obesity is associated with early sexual maturation (Epstein LH et al. 1985; Forbes GB 1987). Nutter (1991) found that the desire to be thin may influence dietary patterns of female athletes even more than do changes in exercise training.

Elite sport may lead to eating disorders. Athletes involved in dance or performance sports (ballet, aerobics instructors, cheerleaders) were significantly more likely to have such problems (moderate effect). Furthermore, “leanness athletes” (gymnasts, figure skaters, divers, aesthetic sports, marathon runners, “weight class” athletes) were also significantly more likely to be diagnosed as having eating disorders or to score more highly on measures or disordered eating (small effect), particularly if competing at an elite level (moderate effect). However, the authors of this study warned that the overall quality of the research reviewed was variable and often fairly poor (Smolak et al., 2000). These findings were later supported by a higher quality study of 186 Norwegian elite female athletes aged 13-39 compared to nonelite athletes and nonathletes, which found that 46.7% of leanness sport athletes scored highly on disordered eating scales compared to 19.8% of non-leanness sport athletes and 21.4% of controls (Torstveit et al., 2008).

Hypoestrogenism (low estrogen levels) – Low estrogen levels are known cause of osteoporosis and osteopenia, the conditions many other studies have linked to scoliosis. Ballet dancers and elite female athletes who train a lot tend to suffer from low estrogen levels, delayed menarche, fractures and scoliosis. Ballet dancers and Rhythmic female gymnastics are thought to suffer from hypoestrogenism because they tend to over exercise (train a lot) and keep low body weights, conditions that can cause low oestrogen levels, delayed menarche, fractures and scoliosis. Low estrogen levels have been linked to scoliosis in a variety of studies. The data in a study of ballet dancers suggested that a delay in menarche and prolonged intervals of amenorrhoea that reflect prolonged hypoestrogenism may predispose ballet dancers to scoliosis and stress fractures (Hamilton, 1986).

Female’s athletes in general have high rates of posture alteration and spine deviation. A likely reason for this is because women, who train excessively, like professional dancers and athletes, may stop menstruating, which lowers their estrogen levels and makes them at risk for osteoporosis, a condition closely linked to scoliosis (Lau, K., 2011). This increased risk of scoliosis and osteoporosis is similar to what happens when women reach menopause. Both athletes and post-menopausal women are at risk for low estrogen levels, fractures, osteopenia, scoliosis and osteoporosis. Perhaps it is because the low estrogen levels that occur in both groups of women caused weakened bones which result in osteoporosis, scoliosis and fractures (Simpson S.).

In the international specialized literature, there are numerous studies regarding the body posture, for various sports branches. In one of his works, Ashton-Miller (2004) consider whether intense training could lead to hyperkyphosis in young athletes, mostly in immature athletes, because of mechanical overloading, lack of age-appropriate recovery and training duration. Ten-fold higher incidence of scoliosis in gymnasts compared with untrained girls established by Tanchev P. et al. 2000 (Tanchev P. et al. 2000). Martinez (2004) assessed the spine in sagittal plane on a sample of 82 female gymnasts aged between 7 and 15, the author found an increase in the lumbar curvature. Pastor (2000) identified a high rate of spinal alterations in swimmers, with various abnormalities depending on the swimming style. Another study on 78 professional soccer players found normal values of the spine in sagittal plane, though the maximal trunk flexion and the asthenic position indicated a kyphotic attitude (Sainz de Baranda, 2001). As for the spinal morphology in canoeists and runners, the latter had significantly higher values for dorsal kyphosis compared to canoeists. No significant differences were found between the two samples of athletes concerning lumbar lordosis (Lopez-Minarro et al., 2009). Several studies have assessed the spine in several sports populations, such as: swimmers (Pastor, 2000; Obayashi et al., 2012), gymnasts (Ohlen & Wredmark, 1989; Kums et al., 2007; Kruse & Lemmen, 2009; Zaharieva&Gencheva 2014), professional soccer players (Sainz de Baranda et al., 2001; Ribeiro et al., 2003) and amateur soccer players (Wodecki, 2002), weight lifters (Lopez-Minarro et al., 2007), tennis players (Barczyk-Pawelec et al., 2012).

Girls engaged in intensive athletic activity often experience chronic energy deficiency, caused by restricted calorie intake (as in disordered eating), excessive exercise (as in high intensity training), or the combination of both (Wheatley et al, 2012). This has significant health consequences, such as hypothalamic amenorrhea, infertility, attainment of low peak bone mass and bone loss leading to fracture (Chan & Mantzoros, 2005; Rackoff & Honig, 2006; Wheatley et al, 2012).

CONCLUSION

The literature is replete with reports that the effects of athletic training on growth and pubertal development can be: salutary, deleterious or nonexistent.

The existence of numerous studies for the relation between elite sports and children's health show actuality of the problem. Training or competitions can be the cause for delay in growth and sexual maturation, shorter stature; eating disorders, weight restriction, decreased body mass, hypoestrogenism, posture and spine deviations, low back pain and etc.

Considerable controversy has existed in the popular media and research literature regarding the effects of participation in elite sport and disordered eating or weight restriction, particularly for "leanness" sports requiring smaller, thinner builds for optimal performance. More studies support possible protective effect of sport involvement on body image and disordered eating among general and elite athletes, with the exception of those involved in aesthetic or leanness sports (gymnastics, cheerleading, weight class sports, marathon running, aesthetic sports) , who appear to be at significantly higher risk.

The distinction between various sports branches is important because they have different training time and intensity. It is therefore important not to assume that research findings in different sport branches apply directly to elite sport as a whole.

The distinction between elite and nonelite athletes is important because the different demands of various sports also dictate the amount of time spent in strenuous physical activity; gymnasts and dancers far exceed swimmers and tennis players in the available studies. It is therefore important not to assume that research findings on elite sport participation apply directly to physical activity.

There are great differences in the methodological procedures of different studies, defining the conditions and age of athletes and sports experience, these are just some of the problems which makes it impossible to determine the cause and effect of the relationship of sports and health fully, which is exactly the reason why there must be further controlled studies conducted that would establish or reject a link between a particular sport and health problems.

The data obtained from this research may be considered a starting point in improving the training process, which mean to achieve sports performance and preventing children's health.

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DIMORFIC DIFFERENCES IN BODY COMPOSITION OF PRE-SCHOOL CHILDREN

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SUMMARY

The aim of the study was to determine the differences in morphological characteristics and body composition in preschool children from Belgrade. The study was conducted on a sample of 110 preschool children divided into two subgroups of 60 boys and 50 girls, mean age 6.25±0.31 years. The InBody 230 apparatus (Biospace Co., Ltd., Seoul, Korea) was used to measure morphological characteristics and provide estimates of body composition. Results of multivariate (MANOVA) analysis of variance revealed statistically significant differences (F=21.364; P=0.000) between the subgroups. Univariate (ANOVA) analysis of variance demonstrated individual differences in variables: *Body Height*, *Body Weight*, *Intracellular fluid*, *Extracellular fluid*, *Total protein amount* in favour of the boys, and in the variables *Total Quantity of Minerals* in favour of the girls. Accordingly the findings led to a conclusion that there are no major changes in the morphology and structure of body composition in either sex. Children at that age are at a similar nutritional status and there are no significant changes in the assessment of body adipose tissue, while larger differences and variability can be expected in the prepubescent period.

Keywords: anthropometry, bioelectrical impedance, nutritional status, seven year-old children.

INTRODUCTION

Body composition or constitution, is the most prominent characteristic of the person. In adults, it represents man's life style, sports activity, success, but also illness. Preschool age, in terms of growth and development, can be defined as a very heterogeneous with uneven level of development that varies with race and gender (Taylor et al., 2002). When trying to define the physical constitution of children special attention should be paid to gender differences in the distribution of body constitution, changes in somatotype, as well as the stability of individual physical constitution during the growth and development (Lonkumer, 2014).

Preschool children, unlike the rest, are still in the process of forming habits, which will continue to reflect on quality of their life. Therefore, overweight and obese children tend to have a lower exercise of physical activity. In recent years The World Health Organization (WHO, 2000) has paid much attention to insufficiency of physical activity, classified it as a risk factor and equated it with the risk factors such as hypertension and obesity that were previously considered to be the only once. For these reasons, lack of physical activity can be linked to an increase in obesity in children. It was found that body fat adversely affects the physical condition, and that the boys in the age group of 6-14 years are significantly different compared to their peers in terms of smaller body mass index (BMI) values and body fat (Ostojić et al., 2011). A Japanese study by Satake et al., (2010) using the computed tomography (CT) examined children who were not obese aged 6-20 years in reference to subcutaneous adipose tissue and vasceral fat has indicated that children aged 6-10 years were similar, while adolescents differ in subcutaneous adipose tissue in favour of the girls and vasceral fat in favour of the boys. The opposite findings regarding the preschool children aged 6-7 years also from Japan were stated by Sakai et al., (2011). The authors have stated that a lower percentage of adipose tissue was found in girls of preschool age, which is explained by entering the phase of early maturation.

There are different approaches to defining and comparison of body composition in children, as well as defining the morphological structure of space and the ways in which physical parameters are obtained and compared. Today we use methods that involve obtaining accurate results of physical composition, such as DXA, hydro-densitometry, plethysmography, bioelectrical impedance-BIA, computed tomography (Schaefer et al., 1994; Goran, Toth, &, Poehlman, 1998). Comparison with DXA showed that the BIA method gives very accurate results (r=0.88) (Boot et al., 1997). If we compare the methods of assessment of body composition over a period of three decades the differences between the authors can be noted. Heinonen et al., (1998) argue that the BIA method gives better results than DXA method because the results are obtained at the level of the whole body, a fact that is designed for the older sample. Further research conducted by Bray et al., (2002), comparing the six different methods for estimating body fat shows that the worst results evaluating body fat were provided by the BIA method. The most efficient method of estimating the percentage proved to be The Pennington 4-compartment model by which the body fat expressed in kilograms is divided by the current body weight and multiply by 100. This is supported by the findings of Eisenmann et al., (2004) indicating that the BIA method in 3-8 years old children has limited use in the assessment of body composition, while the free anthropometric method of body mass index (BMI) and skin folds (SFs) proved more useful in the assessment of body composition and monitoring of obesity. Also, recent research show that the standard anthropometric methods to define the morphological types are still used with some 33% and the BIA method with 25% of all methods used (Silva et al., 2013). The best indicators, and indicators of child growth and development to some extent, are height/weight ratios used to calculate the BMI (body weight (kg)/body height (m2)) as an important indicator of nutritional status and health risks they pose (Janssen, Katzmarzyk, & Ross, 2004). There is a significant correlation between the body mass index and relative obesity in children and adolescents, and therefore represents the most appropriate tool for measuring relative obesity (Bellizzi, &, Dietz, 1999). Monitoring the structure of body composition in terms of percent of body fat and muscle in preschool children is valuable for monitoring the physical growth and development.

Given that today's lifestyle is extremely fast changing and susceptible to changes in the external environment, our aim was to by using the BIA and anthropometric methods identify the differences in the composition of body structure and morphological characteristics of preschool children.

METHODS

Subjects

The sample consisted of 110 children mean age 6.25 ± 0.31 years, divided into two homogeneous subsample groups of 60 boys and 50 girls who at the time of measurement attended preschools April 11th in Novi Beograd. The sample was drawn from the population of preschool children by random sampling method, e.g. quota sampling. This type of pattern has professional and scientific justification when investigating a mass phenomenon and homogenization group (sample) had previously been carried out and therefore the planned research quota sample method can provide very good results and external validity of the study (generalization). The study used non-experimental research design (ex post facto draft), considering that for the research purposes analyses of the relation between independent and dependent variables were needed, and direct control over them was not provided. According to the nature of scientific research the empirical method of research was utilised, the applicative method in regard to assignment and confirmative concerning the problem knowledge. In relation to the duration the transversal method was used, while in relation to the degree of control the semi-laboratory research method was applied. Parents or guardians of children had been informed in writing about the plan, its realisation and duration and asked to sign a consent form in accordance to ethical principles for biomedical research on human (World Medical Association Declaration Of Helsinki, 2013). The measuring has begun at the end of December 2014 after the written consents had been obtained from parents or guardians of children.

Procedure

Anthropometric measures, which are measured in accordance with the guidelines of the International Biological Program (IBP) (Lohman, Roche, &, Martorell, 1988) for the evaluation of longitudinal dimensionality of the skeleton: 1) *Body height* (0.1 cm); to estimate the volume and mass of the body 2) *Body weight* (0.1 kg) and for the evaluation of subcutaneous adipose tissue: 3) *Abdominal skin fold* (0.1 cm), 4) *Back skin fold* (0.1 cm) and 5) *Upper arm skin fold* (0.1 cm).

Based on the values of the *Body height* and *Body weight* variables 6) *BMI* (Body Mass Index) was calculated in a manner that the value of body weight in kilograms was divided by the square of body height in meters, according to the following formula: BMI=(BW (kg) / BH (m^2)).

A sample of measuring instruments for the assessment of body composition was taken by InBody 230 (Biospace Co., Ltd., Seoul, Korea) apparatus, which operates on the basis of bioelectrical impedance and consisted of the following variables: 7) Total amount of muscle (0.1 kg); 8) Total amount of adipose tissue (0.1 kg); 9) Total amount of water (0.1 kg); 10) Intracellular fluid (0.1 kg); 11) Extracellular fluid (0.1 kg); 12) Total amount of protein (0.1 kg); 13) Total amount of mineral particles (0.1 kg), and 14) Fat-free mass (0.1 kg).

When measuring the longitudinal dimensionality of the skeleton we complied with certain standards (IBP). Posture of the respondents was standing (respondent standing barefoot in his underwear, head in the Frankfurt horizontal position). After that, the parameter was defined. The Anthropometry by Martin was the measuring instrument used. The distance from the ground to the top of his head has been measured. The results are expressed as 0.1 cm value. The *Body weight* was measured by digital medical scale with participant standing barefoot in upright position on it. The results are expressed as 0.1 kg value. All skin folds were measured with John Bull type calliper while the respondent was in an upright position. In measuring *Abdominal skin fold* (umbilicus), the measuring assistant lifted the left hand transverse skin fold in place which is 5 cm above the navel. The assistant measured the thickness of the skin fold with the top of the calliper; the measured value is expressed as 1 mm. The result was recorded after the first measuring. The *Back skin fold* (subscapul) was measured in a manner that the measuring assistant lifted the skin fold by his left hand in place at the blades level. The assistant measured the thickness of the skin fold with the top of the calliper; the measured value was expressed as 1 mm. The result was also recorded after the first measuring. The *Upper arm skin fold* had been measured while the respondent was also standing with hands stretched down the body. The assistant measured the thickness of the skin fold by lifting the longitudinal skin fold above the triceps (triceps brachii) at its broadest and, with the top of the calliper, measured the thickness of skin fold. The result was also expressed as 1 mm value and recorded after the first measuring. The BIA analysis was used to estimate body composition. The advantage of this method is that it can be used in clinical conditions and in the field. This method assessed the structure of body composition by broadcasting low, safe doses of electricity (800 micro amps) through the children's body. The current is passed through the body, without resistance of the muscles, while resistance occurred when the current passed through the adipose tissue. This resistance is called bioelectrical impedance, and was measured by a device that estimates body composition. The BIA method has become the reference method in body composition analysis research studies.

Statistical analysis

Statistical analysis included the computation of basic descriptive statistics: starting with measures of central tendency (M) the arithmetic mean of the measures of variability and (SD) standard deviation. To determine statistically significant differences in the overall status of body composition and morphological characteristics between groups of subjects a multivariate (MANOVA) analysis of variance was used, individual statistically significant differences were tested by univariate (ANOVA) analysis of variance.

RESULTS

Table 1 shows the values of the descriptive statistics of the tested variables, and differences in the multivariate and univariate level for both sexes, all at the conclusion of $p < 0.001$. Based on Wilks F test in table 1 it can be concluded that there exist statistically significant differences between boys and girls in the entire tested area of body composition and morphological characteristics.

Individual differences were found in the variables: Body height, Intracellular fluid, Extracellular fluid and in the variable Total amount of protein in favour of the boys, while girls achieve greater and statistically significant values in variable Total amount of minerals. No significant deviations in terms of data distribution normality, which confirm the values of arithmetic means and standard deviations for both sexes.

Table 1. Descriptive statistics and differences in morphological characteristics and body composition

Variable	BoysN(60) M	SD	GirlsN(50) M	SD	f	p
Body Height *(0.1cm.)*	1233.6	41.98	1196.5	50.83	17.59	**0.000**
Body Weight *(0.1kg.)*	245.20	26.66	254.46	39.47	2.13	0.147
Body mass index *(kg/m^2)*	19.87	2.01	20.86	2.59	5.05	0.027
Total amount of muscle *(0.1kg.)*	11.85	2.04	11.17	2.309	2.65	0.106
Total amount of adipose tissue *(0.1kg.)*	5.81	2.43	4.90	2.35	1.41	0.236
Total amount of water *(0.1kg.)*	17.28	2.50	16.27	2.77	4.04	0.047
Intracellular fluid *(0.1kg.)*	10.11	1.36	9.31	1.16	10.64	**0.001**
Extracellular fluid *(0.1kg.)*	6.30	0.85	5.74	0.76	12.96	**0.000**
Total amount of protein *(0.1kg.)*	4.39	0.58	3.99	0.55	13.79	**0.000**
Total amount of mineral particles *(0.1kg.)*	1.53	0.23	1.71	0.21	17.68	**0.000**
Fat-free mass *(0.1kg.)*	22.32	2.98	22.64	2.33	0.36	0.545
Abdominal skin fold *(0.1cm.)*	78.65	36.95	83.08	36.57	0.39	0.531
Back skin fold *(0.1cm.)*	61.88	19.47	64.98	18.50	0.72	0.397
Upper arm skin fold *(0.1cm.)*	89.92	30.20	85.22	26.31	0.74	0.391

F=21.364; P=**0.000**

Legend: M - arithmetic mean; S - standard deviation; f - f univariate test; p - level of statistical significance test f; F - Wilks multivariate F test; P -multivariate F test statistical significance.

DISCUSSION

Results of the analyses of the morphological characteristics and body composition in boys and girls have indicated certain, but not essential difference, realized in the longitudinal dimensionality of the skeleton and variables that estimate the total amount of intracellular and extracellular water amounts in favour of the boys. The boys compared with their female peers also displayed higher values of total amount of protein mass in the body. Certainly, it should not be claimed that the values of these parameters in girls are substantially reduced since it should be confirmed by clinical-laboratory methods. However, it is necessary to emphasise the importance of these fluids in children. That is, when the values of the extracellular fluid are extremely reduced, intracellular fluid experiences more intensive osmosis. This phenomenon in children can lead to different CNS states manifested by vomiting, drowsiness, confusion, and headache. In the past the thesis that a proper diet regime must contain a large amount of protein was widely accepted. Accordingly, the quality of the diet does not depend on the amount of protein and of their origin, but on the use of a variety of healthy ingredients. Foods rich in protein and calories, consumed by children in developed countries and affects faster growth, can lead to serious consequences in adolescence and later periods of life: obesity, diabetes and atherosclerosis (Nader et al., 2006). Experience from the US shows that, along with the increase in the prevalence, the overweight children suffer more difficult obesity conditions. The findings clearly point to that (Sturm, 2007). The author has stated that from year 2000 to year 2005, the prevalence of obesity in BMI>30 increased by 24%, BMI>40 by 50%, and the prevalence of BMI>50 was increased by 75%. Even earlier survey conducted by Abraham et al., (1971) indicates that excessive weight at young age represents a significant predictive factor in the old age. The data suggests that excessive weight among children in Europe has continued increasing during the last three decades, and that this is particularly manifested in the countries of south Europe (Lobstein, & Frelut, 2003). No major deviations were found regarding the body weight in the tested sample in question, as well as body mass index, although the average values indicate that girls are slightly heavier and with greater BMI values. These values were found to be statistically significantly different. Average values of BMI in boys amounted to (BMI=19.87±2.01) and in girls (BMI=20.86±2.59). From this fact we can conclude that children of both sexes are the normal nutritional status as prescribed by the National Institutes of Health (1988), which indicates that the normal weight of children at this age are those children whose BMI values are in the range between (BMI=18.5-24.9 kg/m2). The research results indicate that both boys and girls at a satisfactory level of nutrition, and that the essential difference between them in body composition observed are consistent with the findings of Wachira et al., (2014), but it is also obvious that in the test age for this sample the growth of long tubular bones in boys is more pronounced and faster than in girls. Uneven bodily growth and development, as well as the intensity of certain processes in the body are responsible for the bone growth in length in male subjects. A recent study presented by Stamm et al., (2014) suggest that there are gender differences in the height/weight ratio and a growing tendency in their increase, still, the differences are most notable in high school children and somewhat less in younger children. Contrary to this fact speaks the research by Rush et al., (2014) conducted among children aged 1 to 3 years in Europe, Indonesia and Polynesia. The authors note that the boys did not differ in height and weight, while the Indian girls had lower body weight than European girls, and Polynesian girls had higher body weight. Percent of body fat was different. Greater amount of abdominal adipose tissue mass was found in boys than in girls, and less muscle mass was found in Indian boys than the European. Therefore, defining the physical constitution of children poses quite a big problem, since children do not yet have a stable reference characteristics because they vary depending on gender, age, race, body height and body fat as confirmed by the research (Hannan et al., 1995; Daniels, Khoury, &, Morrison, 1997). The variables for evaluation of subcutaneous blubber and total body fat indicate that the differences between sexes do not exist, which is confirmed by Mast et al., (1998) research conducted in Germany in 5-7 years old children where differences in adipose tissue were not observed, as opposed to differences in body weight and BMI in favour of the boys. Contrary to the findings in 3-8 years old children in favour of smaller average values of body fat assessed by DXA method by (Taylor et al., 1997). The authors suggest that for the first time this method pointed out the significant differences in the adipose tissue that increased by 50% in girls before the onset of puberty. The study on the validity of the assessment of body composition in children aged 4 to 10 years performed by Bammann et al., (2011) in four European countries indicates that it is possible to estimate body composition in subjects younger than the age of 6 and that children differ less in body composition with age, while it is present depending on place of residence. Girls had higher average total quantity of minerals in the body. It is obvious that at that period the girls have not yet entered a phase of rapid growth, but higher values of the total amount of minerals in the body found in girls, and reduced values of extra and intracellular fluid may indicate differences in hormonal status between the genders. Due to greater amounts of minerals that are integral parts of many enzymes, girls probably have better body regulation mechanisms.

CONCLUSION

As the scientific community is increasingly becoming occupied by obesity in children, there is a growing need to monitor obesity and improve the cardiovascular status of children (Burdyukova, 2012). Although the investigated sample was of normal nutritional status, we believe that monitoring nutritional status of children has an exceptional public importance since it is associated with many cardiovascular diseases, hypertension, diabetes, that are the leading causes of mortality in adulthood in developed countries, what (Holbrook et al., 1990; Sjostrom, 1992) point at. The authors suggest that the state of anthropological dimensions in preschool children needs continual monitoring, and that body composition be monitored using the anthropometric and BIA methods suitable for use in field conditions, with the aim to enable planning and adjusting of kinesiology transformational programming process in accordance with the current requirements. Within the growth and development and mutual relations of morphological dimensions and body composition with nutritional status, certain rules can be defined. Those depend on the endogenous and exogenous factors, particularly on gender, as the results of number of the research have showed. Attempts to define the particular rules, or at least a tendency, are based on the fact that individual differences among children are the generators of different bodily constitution, as well as types. These results may be further verified in other and larger samples of children. The authors recommend that the age categories be further defined and age intervals shortened up to three months since physical development in preschool children is slightly slower compared to the cognitive, affective and motor.

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THE FREQUENCY OF SCOLIOTIC BODY POSTURE AMONG YOUNG CHILDREN IN KNJAŽEVAC

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SUMMARY

The aim of this study was to determine the frequency of scoliotic posture among preschool and young school age children living on the territory of the municipality of Knjaževac. The sample of participants consisted of 515 young school age children and 125 preschool children. To evaluate the scoliotic body posture, the "Spinal Mouse" measuring instrument was used. For the statistical analysis, the Chi square test was used. There is a statistically significant higher number of children with no scoliotic posture in both age categories. Among the preschool children, the most dominant is the thoracic left scoliosis, and the least frequent is the complete and right thoracic scoliosis. Among the younger school age children, the lumbar left scoliosis is the most frequent. Among the young school age children, the most frequent spinal deformity is left lumbar scoliosis. In addition, no child showed signs of thoracic right scoliosis. When it comes to the gender of the participants, there is no significant difference between the boys and girls in terms of the number of children with scoliotic posture. Based on the obtained results and the ensuing analyses, we can conclude that on the territory of the Knjaževac municipality, there is a relatively small number of preschool children, 10.4%, and young school age children, 22.5%, with scoliotic body posture. Considering that the frequency of the occurrence of scoliotic posture increases by a little more than 10% between the preschool and young school age, it is necessary to carry out corrective gymnastic exercises, so that this percentage would not increase during puberty.

Keywords: scoliosis, gender, differences, distribution

INTRODUCTION

Unlike kyphosis and lordosis, which represent physiological curves of the spinal column in the sagittal plane, the spinal column should be completely straight in the frontal plane. Every deviation from the normal position of the spinal column in the frontal plane is referred to as scoliosis or scoliotic body posture. This term includes lateral deviations of the spinal column, manifested in the frontal plane (Milenković, 2007). In relation to the effects scoliosis can have on the locomotor apparatus, it can be both functional and structural. Functional scoliosis is a postural disorder of the spinal column, where the curves of the spinal column are not fixed, the rotation of the vertebra is minimal, or non-existent, and the scoliosis itself is lost during the flexing of the torso and in the prone position, so that the bones and ligaments of the spinal column suffer no structural changes (Živković, 1998). This is actually the initial phase of scoliosis where the angle of the deviation from the normal position does not exceed 15 degrees and can be corrected by means corrective gymnastics. It is also referred to as scoliotic body posture, precisely because it can be corrected through exercise. Structural scoliosis occurs as the result of degenerative changes to the spinal column with the accompanying changes in the structure and morphology of the vertebra, where vertebra rotation is unavoidable. In the case of this deformity, the body of the vertebra is asymmetrical, wedge shaped, and the horizontal spinal endings change their position due to the present rotation component. This is especially pronounced if the deformity is located in the thoracic part of the spinal column, where an additional occurrence is the rib hump (Živković, 2009). Compared to the shape of the curve of the spinal column, scoliosis can be: partial, complete and compensatory. In the case of partial scoliosis, the curve is only present in the thoracic or lumbar region. Complete scoliosis is a disorder which affects the entire length of the spinal column. The curve can be to the right or left side, and if there is only one curve in the spinal column, then this scoliosis is referred to as full left or right scoliosis (Milenković, 2007). In the case of compensatory scoliosis, in one part of the spinal column there is a deviation to one side, and above or below that deviation, there is a deviation to the opposite side. This type of scoliosis is also known as duplex scoliosis, and can take the shape of the letter S. If the state of these postural disorders in the spinal column, or in the locomotor apparatus in general, is determined early on, there is a more positive prognosis that the postural disorder can be corrected.

In accordance with the aforementioned aim of this study, the goal was to determine the frequency of the scoliotic posture among preschool children and young school age children living on the territory of the municipality of Knjaževac.

METHODS

Subjects

A total of 515 young school age children participated in the study (first to fourth grade elementary school students) along with 125 preschool children from the territory of the municipality of Knjaževac.

Procedure

In order to evaluate the deviation from the normal position of the spinal column in the frontal plane, the "Spinal Mouse" (Idiag, Fehraltdorf, Switzerland, www.idiag.ch) measuring instrument was used. It is a non-invasive type of measuring of the postural status, and relies on the use of the corresponding software. This measuring instrument was already used in studies involving the school age population in studies carried out by Bubanj, Živković, Živković, Milenković, Bubanj et al. (2012). The validity and reliability of this instrument was verified in the studies of Mannion, Knecht, Balaban, Dvorak & Grob (2004); Post & Leferink (2004).

Statistical analysis

All of the data will be presented numerically and in percentages. In order to determine whether there is a statistically significant difference in the distribution of the scoliotic posture in relation to the normal postural status, and especially in relation to gender, the Chi square test was used.

RESULTS

Tables 1. to 5. show the results for the distribution of scoliotic posture among preschool children.

The results shown in table 1. indicate that 10.4% of preschool children have some form of scoliotic posture. Of these forms, the most frequent is the thoracic left scoliosis, and the least frequent is the thoracic right and compensatory scoliosis.

Table 1. The distribution of scoliotic posture among preschool children

Variables	Frequency	Percent
N	112	89.6
K	1	0.8
C	2	1.6
TL	4	3.2
TD	1	0.8
LL	3	2.4
LD	2	1.6
Total	125	100

N-no scoliosis, K-compensatory, C-complete scoliosis, TL-thoracic left, TD-thoracic right, LL-lumbar left, LD-lumbar right

Table 2. The results of the Chi square test for the preschool children

Variables	Frequency	Percent	Chi square test	
N	112	89.6	Chi-Square	78.408
SKO	13	10.4	df	1
Total	125	100	Asymp. Sig.	.000

N- no scoliosis, SKO- scoliotic body posture

Table 3. The distribution among preschool boys

Variables	Frequency	Percent
N	64	92.8
K	1	1.4
C	2	2.9
LL	1	1.4
LD	1	1.4
Total	69	100

N-no scoliosis, K-compensatory, C-complete scoliosis, LL-lumbar left, LD-lumbar right

The results of the Chi square test shown in table 2. and indicate a statistically significant higher number of preschool children with no scoliotic body posture.

The results shown in table 3. indicate that among the boys, the most widely distributed is complete scoliosis, followed by compensatory and lumbar scoliosis. Among the boys, no thoracic scoliosis was determined.

Table 4. Distribution among preschool girls

Variables	Frequency	Percent
N	48	85.7
TL	4	7.1
TD	1	1.8
LL	2	3.6
LD	1	1.8
Total	56	100

N-no scoliosis, TL-thoracic left, TD-thoracic right, LL-lumbar left, LD-lumbar right

The results shown in table 4. indicate that among the girls, the most widely distributed is the thoracic left scoliosis, followed by the left lumbar and finally thoracic and right lumbar scoliosis. Among the girls no compensatory or complete scoliosis was detected.

The results shown in table 5. indicate that among the boys and girls there are no statistically significant differences in the number of children with scoliotic body posture.

Table 5. The results of the Chi square test for the differences in terms of gender

Pol	Frequency	Percent	Chi square test	
B	5	38.5	Chi-Square	.692
G	8	61.5	df	1
Total	13	100	Asymp. Sig.	.405

B-boys, G-girls

Tables 6. to 10. show the results which refer to the distribution of scoliotic posture among young school age children.

In this population, 22.5% of the children have scoliotic posture. According to the results shown in table 6., the most frequent is lumbar scoliosis, and the least frequent is complete scoliosis. No children showed signs of thoracic right scoliosis.

Table 6. The distribution of scoliotic posture among young school age children

Variables	Frequency	Percent
N	399	77.5
K	10	1.9
C	3	0.6
TL	30	5.8
LL	37	7.2
LD	36	7.0
Total	515	100

N-no scoliosis, K-compensatory, C-complete scoliosis, TL-thoracic left, LL-lumbar left, LD-lumbar right

Among the young school age children there is a statistically significant greater number of children with no scoliotic posture, which is indicated by the results of the Chi square test shown in table 7.

Table 7. The results of the Chi square test for the young school age children

Variables	Frequency	Percent	Chi square test	
N	399	77.5	Chi-Square	155.513
SKO	116	22.5	df	1
Total	515	100	Asymp. Sig.	.000

N - no scoliosis, SKO - scoliotic posture

Among the young school age boys, based on the results shown in table 8., the most frequent is right lumbar scoliosis and the least frequent is complete scoliosis.

Table 8. The distribution among young school age boys

Variables	Frequency	Percent
N	192	77.1
K	4	1.6
C	3	1.2
TL	14	5.6
LL	16	6.4
LD	20	8.0
Total	249	100

N-no scoliosis, K-compensatory, C-complete scoliosis, TL-thoracic left, LL-lumbar left, LD-lumbar right

In the case of the girls, according to the results shown in table 9., the most widely distributed is left lumbar scoliosis, and the least widely distributed is compensatory scoliosis.

Table 9. The distribution among young school age girls

Variables	Frequency	Percent
N	207	77.8
K	6	2.3
TL	16	6.0
LL	21	7.9
LD	16	6.0
Total	266	100

N-no scoliosis, K-compensatory, C-complete scoliosis, TL-thoracic left, LL-lumbar left, LD-lumbar right

Table 10. The results of the Chi square test for the differences in terms of gender

Pol	Frequency	Percent	Chi square test	
B	57	49.1	Chi-Square	.034
G	59	50.9	df	1
Total	116	100	Asymp. Sig.	.853

B-boys, G-girls

The results shown in table 10. indicate that in relation to gender, there is no statistically significant difference in the number of children with scoliotic body posture.

DISCUSSION

In the case of preschool children, there is a statistically significant smaller number of children with scoliotic posture, and that percentage is approximately 10%. In terms of the distribution of the different types of scoliosis, the most frequent type is thoracic left and lumbar left scoliosis. What is positive is the small presence of compensatory and complete scoliosis, considering that they represent the most severe forms of scoliosis when it comes to applying corrective gymnastics. In relation to gender, scoliosis is more widely distributed among the girls, with 61.5% as compared to 38.5% among the boys. Considering that we are dealing with idiopathic scoliosis, since no child showed signs of myopathic, neuropathic or osteopathic scoliosis, the obtained data are in agreement with the results obtained by other authors (Živković, 1998), according to which the greatest frequency of this type of scoliosis is determined among girls, in comparison to boys. Contrary to the results of this study, Romanov, Stupar, Međedović, & Brkin (2014) determined a greater percentage of children with scoliotic posture. In their study, the percentage was 24.11%. On the other hand, unlike their results, and those obtained in this study, Simov, Minić, & Stojanović (2011) determined a significantly smaller number of children from the same population suffering from scoliosis, just 1.14%. The reason for the differences in these percentages of children with scoliotic posture could be found in how the postural disorder is determined, that is, in the choice of different methodologies. In the case of young school age children, there is still a significantly greater number of children without scoliotic posture. However, in comparison to preschool children, the percentage of children with some form of scoliosis is greater by approximately 12% and has a value of 22.5%. An increase in the percentage of children with a spinal column deviation in the frontal plane, in relation to age, leads us to the assumption that in the case of young school age children, very little corrective work is done for proper body posture. In this age group, the most frequent type of scoliosis is lumbar left and right scoliosis, and thoracic left. A greater prevalence of lumbar scoliosis can be ascribed to the different spans of time it takes for the legs to grown during periods of growth and development. In addition, another reason could be an asymmetrically extended m. iliopsoas. In the case of gender, scoliotic posture is equally present among both girls and boys. The percentage of children with scoliosis in this study is greater in comparison to that presented in the study of Beganović & Bešović (2012), where it had a value of 13%, and in the study of Hodžić, Gerdijan, Mikić, & Katanić, N (2010), where it had a value of 9.6%.

CONCLUSION

Based on the obtained results and the ensuing analyses, it can be concluded that on the territory of the municipality of Knjaževac, a relatively small number of preschool children, 10.4%, and young school age children, 22.5%, suffer from scoliotic posture. Considering that the frequency of children with scoliotic posture increased by slightly more than 10% between the preschool and young school age, it is necessary to carry out corrective gymnastics exercises, in an organized manner, so that this percentage would not increase during puberty.

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ACTIVE TIME OF EXERCISING WITH DIRECTED ACTIVITIES

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SUMMARY

The goal of this research was to evaluate eventual influence of gender on active time of exercising by the phases of directed motor activity, as well as on total active time of exercising of preschool children on directed motor activities. We started with the assumption that gender would influence active time of exercising by phases of activities, as well as on total time of exercising on directed motor activities in physical education. The research was realized in kindergarten "Decja Radost" in Svilajnac, Republic of Serbia in the second term of 2014/2015 school year. In order to determine active time of exercising by phases and total active time of exercising on directed motor activity in relation to gender 33 activities were monitored. Time of activity (engagement) was measured by random choice of one child and its monitoring by the person who measured during the directed activity. When the child is active, the person who measures activates the stopwatch and when the child stops with the activity the person who measures deactivates the stopwatch and records the result in seconds into the form. After finishing the exercise on directed activity the measured times are added together, the activity percent is calculated (engagement) by phases of directed activity and in total. The child whose active time of exercising is measured must not know that he/she is an object of monitoring and measuring. The sample of examinees consisted of 16 boys and 17 girls six and seven year old. In the processing of data which were obtained by empirical research apart from descriptive statistics, t-test was also used for small independent samples. Very small difference in active time of exercising in all phases of directed activity is in favour of boys, as well as total active time of exercising. The values of t-test do not indicate statistically significant differences between boys and girls of preschool age in relation to the length of their exercising by phases and total active time of exercising on directed activities.

Key words: active time of exercising, directed motor activity, t-test, preschool age

INTRODUCTION

In EU countries there has been an attitude that well trained preschool teachers who work in appropriate (fair) conditions represent the most important precondition of high quality education and upbringing. Preschool education and upbringing is the first level of basic education in educational system and it is necessary to make it available to all children.

Preschool upbringing is a valuable investment in future. Sufficient money must be obtained in the education budget. The states have to make great efforts to secure equality and involvement of all children, especially those in adverse environment and those children with special needs.

Physical education as planned and creative activity, with clearly defined goals starts in institutional education of the Republic of Serbia with preschool upbringing and it ends most often with the end of secondary school education.

The central point of problem-weaknesses of physical education the following is cited most often: insufficiently organized planned work in preschools and lower grades of primary school, smaller ability of preschool tutors and teachers to realize complex tasks of physical education, uneven, often poor material conditions in schools for the realization of physical education and students still do not get theoretical knowledge properly and on the level which is planned by curriculum.

Physical activity of the youngsters is not satisfactory by its extent, and even less by the intensity. Situation is especially alarming in urban districts. Physical education of preschool children is important because of integral development, biological-health aspect and educational aspect (Djordjic, 2002).

The research of Planinsec (2002) indicates that during growth and development there are phases of intensive development of motor abilities as well as the phases of lower development. These results enable all trainers of motor abilities and who work with preschool children proper and practical planning and programming as to use maximally the phases of intensive development of certain motor abilities.

If you approach physical education teaching inadequately and with no quality or it is finished very early, students are opt to stop physical activities, with the consequence of not doing it later, because they did not acquire skills and habits for regular practicing of physical activities during life span (Hardman, 2008).

The goal of physical education of preschool children is, above all, to contribute to total development of personality, primarily to the development of physical, functional and motor abilities, preservation and improvement of health, more content and more useful spending of time and development of positive personality characteristics (Blagajac, 1995, 18).

Planning of physical education from preschool to secondary school age represents the most important phase of work, the most important didactic procedure which is important for final results of educational process.

During planning and programming three levels are predicted: yearly planning of educational goals and tutors' tasks, successive weekly planning (in advance for five days every week) and daily planning ("daily sketch").

By preschool programme the following is determined: goals, extent, forms and duration of educational work. Preschool programme, depending on the age contains: programme of upbringing work and care with children from the age of three, as well as the programme of educational work with children from the age of three up to their start to primary school, which includes preparatory preschool programme.

The directed activity in physical education of preschool children implies basic organizational unit of educational and upbringing work, i.e. basic form of work, in physical education of the youngsters (Milanovic and Stamatovic, 2006, 33).

The directed activity in physical education is realized by determined programme and timetable: younger group once a week, medium group two times a week, and older group three times a week (Rodic, 2013).

The duration of directed activity depends on age ability and interest for work and it is: in younger age group 20 minutes, in medium age group 25 minutes and in older age group 30 minutes (Djurkovic, 1995).

The directed motor activity should not last longer than 30 minutes. Maximal number of children in a group is 12-14. Children at this age develop motor abilities in the best way if physical activities during directed motor activity are often changed. You should start with simple loco motor activities, then you should go to manipulative activities (throwing, catching, shooting and other), and then on non manipulative activities (stretching, jumping and so on). In the end you should apply rhythmic activities (Sanders, 1996).

The interest for the effects of physical education i.e. active time of exercising and eventual gender favoring is seen during directed activities and it is significant because of the tutors' profession because traditionally in our country it is profession for women.

It is important to mention the research of Jankovic (2013) which had for its goal the determination of effective time of work with children on directed motor activities in kindergarten, and that implies monitoring of duration of directed motor activities and motor engagement of children during each part in the structure of activity. The sample for this research consisted of 166 examinees (84 boys and 82 girls) in preparatory preschool programme, which was chosen from five kindergartens in Novi Sad. For the monitoring of the duration of the activities and engagement chronometer was used. It was stated that activities last on average 1.794,8 seconds (29, 55 minutes) and that children are engaged on average 1/024, 8 seconds (17, 07 minutes). Motor engagement in relation to the duration of directed body activities if longest in preparatory part (22, 9%), while it is shortest in the main B-part of the activity (5, 7%).

The smallest number of realized researches is for children aged seven, because children cannot understand the purpose of performing of motor task, which is conditions by the end of myelinization of nervous system which is happening at that time and conditions the time of keeping child's attention (Markovic, 2009).

This research had a goal to evaluate eventual influence of gender on active time of exercising by phases of directed motor activity and on total active time of exercising of preschool children on directed motor activities.

METHODS

This research was realized in kindergarten "Decja Radost" in Svilajnac, Republic of Serbia in the second term of 2014/2015 school year. In order to determine active time of exercising by phases and total active time on directed motor activity in relation to gender 33 activities were monitored. The time of activity (engagement) was measured by random choice of one child and its monitoring by the person who measured during the directed activity. When a child is active, the person starts stopwatch, and when a child stops exercising, the person sops the stopwatch and records the result in seconds into a form. After finishing the exercise on directed activity the times are added together, the percent of activity is calculated (engagement) by phases of directed activity and in total. The child whose active time of exercising is measured must not know that he or she is an object of measurement.

The sample consisted of 16 boys and 17 girls six and seven year old. In the processing of data acquired by empirical research apart from descriptive statistics, t-test was also used for small independent samples.

Some phases of directed motor activities were structured with the following absolute duration: first phase A (introductory) – five minutes, first B phase (preparatory) – five minutes, main phase – fifteen minutes and final phase – five minutes.

RESULTS

By the insight into the Table 1. we can see that the values of duration of active time of exercising by phases and total active time of exercising are in relatively possible and expected limits. Bigger deviations from the middle value for boys and girls were not obtained in neither phase of directed motor activity.

Table 1. Descriptive parameters for certain phases of directed activities in relation to boys

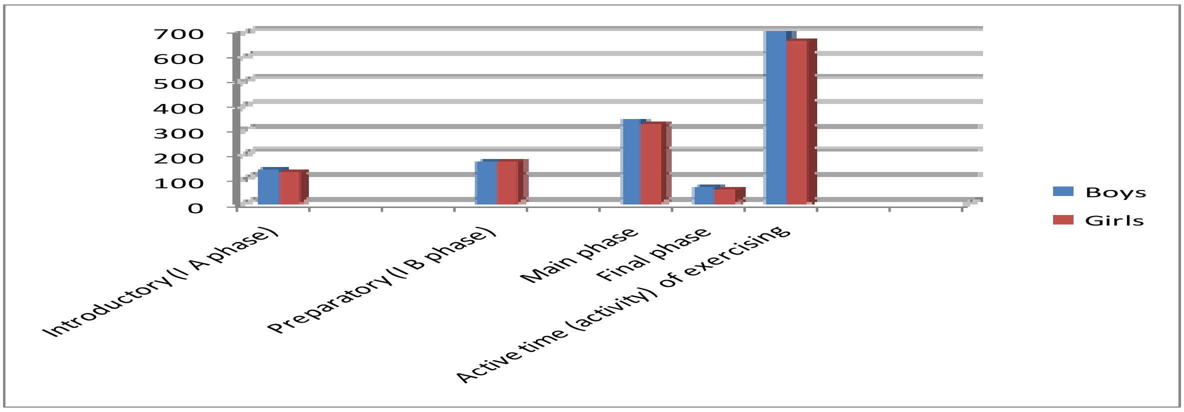
	Minimum	Maximum	Mean	Std. Deviation
Introductory (I A phase)	52	251	133.19	62.75
Preparatory (I B phase)	90	230	165.69	52.25
Main phase	149	503	337.50	86.61
Final phase	24	131	61.06	36.15
Active time (activity) of exercising	454	916	698.06	135.84

In the first phase A phase (introductory) active time of exercising of boys is 133.19 seconds, and for girls 124.47 seconds. The difference of 8.72 seconds is in favor of the boys. In the first B phase (preparatory) the boys also achieved longer active time of exercising with only 2.25 seconds in relation to the girls. The difference in active time of exercising in the main phase is 17.68 seconds and it is also in favor of the boys. Minimal difference of only 8.94 seconds is in favor of boys in the final phase. The expected bigger differences were not acquired in the total active time of exercising on directed motor activity between boys and girls.

Table 2. Descriptive parameters for certain phases of directed activities in relation to girls

	Minimum	Maximum	Mean	Std. Deviation
Introductory (I A phase)	59	205	124.47	56.69
Preparatory (I B phase)	99	242	167.94	44.88
Main phase	143	436	319.82	89.99
Final phase	14	135	52.12	36.97
Active time (activity) of exercising	418	842	664.53	111.22

Graph 1. Presence of active time of exercising by phases of directed motor activity and active time (activity) of exercising in relation to gender



Diagrams of axis on Graph 1. show minimal differences between boys and girls in active time of exercising in the first A phase (introductory), the first B phase (preparatory), second phase (main) and third phase (final) of directed activity in favor of the boys. Minimal difference between boys and girls in total active time of exercising on directed motor activity is also in favor of the boys.

Table 3. *Significance of duration of active time of exercising by phases and total active time of exercising on directed motor activity in relation to gender*

	t	df	Sig. (2-tailed)
Introductory (I A phase)	0,419	31	0,678
Preparatory (I B phase)	-0,133	31	0,895
Main phase	0,574	31	0,570
Final phase	0,702	31	0,488
Active time (activity) of exercising	0,778	31	0,442

The values of t-test indicate that between the active time of exercising for introductory (I A phase), preparatory (I B phase), main and final phase there is no statistically significant difference in relation to gender.

Statistically significant difference has not been stated for the total active time of exercising on directed motor activity between boys and girls.

DISCUSSION

By the analysis of minimal and maximal values for boys it can be stated that for the minimal value of active time in the first A phase in relation to the absolute time of duration of the first A phase utilization is only 17.33%, and for maximal value 83.66%. For the first B phase the difference is smaller and minimal utilization is about 30%, and maximal 76.60%. The situation is very serious by the insight into minimal percent utilization with only 16.55% and maximal 55.88% in the main phase. The lowest active utilization is in the final phase where the minimal value is 8% and maximal 43.66%. All of this has conditioned that we have activities where the minimal active time in final phase is only 25.22% and maximal is 50.88%.

By the analysis of minimal and maximal values for girls it can be stated that for minimal value of active time of exercising in the first A phase in relation to the absolute time of duration of the first A phase the utilization is only 19.66% and for maximal value it is 68.33% For the first B phase minimal utilization is 33% and maximal 80.66%. The situation is almost the same as for the boys; it is very concerning by the insight in minimal percent utilization of 15.88% and maximal of 48.44% in the main phase. The smallest percent utilization in relation to absolute duration is in final phase where minimal value is 4.66% and maximal 45%. All this has conditioned that we have values where the minimal active time in final phase is only 25.22% and maximal 50.88%.

The lowest active time of exercising for boys from 20.35% and for girls from 17.37% on directed activities was obtained in the final phase. Low utilization of the predicted time can be explained by disrespect of time articulation of certain phases, so that main phase is often connected with final phase and in this way the tasks of final phase of directed activity are not achieved. Apart from this, there are a large number of children in a group and inadequate choice of the game causes that children are active for a short period of time. A lot of tutors during realization of directed activities do not respect the structure and the duration of certain phases of directed activity.

The longest active time of exercising after the first A phase (introductory) is at the first B phase (preparatory), where for boys the average active time of exercising is 55.23% and maximal 76.60%. Almost identical situation is for the girls where in the first B phase (preparatory) average active time of exercising is 55.98% and maximal is 80.60%. Active time of exercising is mostly conditioned by frontal work, where children together with the tutor perform shape exercises.

Low active time in the main phase of directed activity from 37.5% for boys and 35.53% for girls can be explained by the choice of content, ways of work, methods, inadequate application of methodological and organizational forms of work, a large number of children in a group, inadequate material and space conditions, inadequate number of equipment and theoretical and practical knowledge of tutors.

The total active time of exercising for boys from 11.63 minutes (38.78%) and for girls from 11.07 minutes (36.91%) is insufficient if we have in mind that children have one to three weekly activities depending on their age, in this way we know that children in preschools do not exercise enough. The exercise effects are minimal with the aim of developing motor abilities, acquiring new motor knowledge, as well as theoretically necessary for accepting of physical education in free time. A low scale of acquired sport technical and theoretical knowledge in the later period bring about low interest for body movement and exercising, and for a large number of girls in older primary school and secondary school age total disinterest, which is followed by freeing from physical education lessons and by total alienation from physical education.

The research Hinkley et al. (2007) indicates that boys are more active than girls, then that the children of more active parents show more activity by doing physical activities. They have also indicated that children who spend most of their time outside show more prominent physical activity in relation to children who spend most of the day inside.

A bad lifestyle of adolescents is very worrying. they show less interest for participating in school sport teams or sport clubs in comparison when they were boys (U.S. department of Health and Human Services, 1999.)This is more expressed for girls than for boys.

Physical education has to give girls and boys the same chance to acquire needed knowledge and practices in forming of positive attitude about the significance of physical exercising for their later life.

During school years by the use of teaching technologies gender favouring of boys appears by the use of public or secret curriculum, which contributes to bigger sport and technical knowledge and better motor abilities (Djordjic and Krneta, 2007).

The research of Sekeljic and Stamatovic (2010) indicates that applied teaching does not have elements of gender favoring in younger school age, but we can talk about favoring of more capable students independently from their gender, and that gender differences are formed during secondary school where teaching practice does not meet specific affinities and needs of female students because of which they do not promote sufficiently physical activity during critical developmental stages between childhood and adulthood, which as a consequence shows that they have weaker physical abilities (U.S Department of Health and Human Services, 1999).

CONCLUSION

Former very rare researches of preschool population, especially active time of exercising, as well as physiological loads during morning exercising, directed activities and movement games, should be confirmed by further researches on bigger more representative samples of both genders, from different socio economic and social areas with the aim of promoting high quality physical education in the earliest ages, and this will be acquired by educating of high quality teachers on pedagogical faculties and faculties of sport and physical education. Insufficient use of absolute time of the duration of directed activity of 30 minutes with only ten minutes shows inadequate expert and methodical ability of teachers and tutors for the realization of teaching contents. A very small number of expert associates in preschool institutions (physical education professors) are insufficient for crucial moves for needed high quality physical education for preschool children.

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CANONICAL CORRELATION BETWEEN FUNCTIONAL ABILITIES AND MOTOR AGILITY IN PRIMARY SCHOOL PUPILS

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SUMMARY

The research was carried out on a sample of 46 subjects, primary school pupils in Niš, aged 11 ± 6 months, who regularly took part in Physical Education classes and trained in their school sports section. The aim of the research was to determine statistically significant canonical correlations between functional abilities and motor agility of the participans. For the estimation of functional abilities the following three tests were applied: Margaria test (FMARG), Pulse frequency after the load (FPPO) and Vital lung capacity (FVKPL). Motor agility was measured by the following tests: envelope test (MKOT), side step test (MKUS) and the eight with bending (MOSS). The results of the canonical correlation analysis have indicated significant relations between functional abilities and motor agility.

Key words: functional abilities, motor agility, canonical correlation analysis, primary school athletes.

INTRODUCTION

A great number of movement structures and situations in Physical Education and sports point to the fact that success in achieving results is determined by a considerable number of complex abilities, and some among them, such as functional and motor abilities, which can be measured and analyzed, are preconditions for preserving and improving their psychophysical health, as well as for achieving high sports results (Ivanović, 2013).

Functional abilities of man imply unity of functional body structures and their mutual functioning (Malacko & Rađo, 2004). They are highly complex and depend on variable and numerous factors, first of all on the vegetative nervous and endocrine system. Functional abilities can be described in a physiological sense as aerobic and anaerobic abilities. They have a major impact on the results of motor behavior of children, since in an appropriate correlation with motor agility they positively contribute to the achievement of sports results (Marinković, 2012., Malacko i Rađo 2005).

Agility is defined as the ability to decelerate, accelerate and change direction quickly while maintaining good body control without decreasing speed. Agility represents a complex motor ability, in whose display other motor skills, such as strength, power, speed, balance, etc., have a specific role. In essence, agility is a movement characterized by a change in velocity (acceleration, deceleration) and direction of movement.

Due to the fact that both motor agility and functional abilities are very important for sports success, these athletic attributes are of special interest for coaches, Physical Education teachers, instructors and psychologists. Therefore, the determination of the relations between agility and other segments of anthropological status of students at present represents a very current practical and theoretical problem.

The research into the correlations between different segments of anthropological status of man, was the subject matter of a large number of research studies conducted on the population of schoolchildren *(Stojiljković, 2005; Stanojević, I.,Pavlović 2006, Veličković, 2009., Malacko i Popović, 2006).* The obtained results of their research have shown that in schoolschildren athletes functional abilities significantly contribute to the achieved sports results.

The aim of this research was to determine statistically significant canonical correlations between the functional abilities and motor agility dimension in primary school pupils involved in training process in school sport sections.

By the realization of such an objective one would create possibility to enable the establishment of more rational procedures for more optimal planning, programming and monitoring of the Physical Education and training process in order to verify harmonization of their development and if possible, to determine more valid and more purposeful guidelines for their further anthropological development and control of the process of Physical Education classes *(Malacko i Rađa, 2004).*

METHOD

The sample of participants

The sample of participants was composed of 46 subjects, all of them 5th grade pupils of elementary school "Bubanjski heroji" in Niš, aged 11 ± 6 month, who were, in 2014/2015 school year, in addition to regular Physical Education classes, involved in training program in school sports section designed to improve gymnastic element technique.

All of the participants were healthy, without any bodily deformities and they voluntarily took part in the testing. They were explained the objective of the research, as well as the protocols for the evaluation of functional abilities and motor agility.

The sample of measuring instruments

For the evaluation of functional abilities, the samples of the following standard tests were applied: Margaria test (FMARG), Pulse frequency after the load (FPPO) and Vital lung capacity (FVKPL). Functional tests were selected according to the research of Heimer & Medved, 1997; Đurašković, 2001.

Motor agility was evaluated by using three tests: envelope test (MKOT), side steps (MKUS) and the eight with bending (MOSS).The applied set of variables for motor agility was taken from the research of Kurelić et al., 1975.

All measurement procedures and all testing protocols were in accordance with the standard methodological requirements that apply to this type of research.

DATA PROCESSING

To determine the relationships between functional abilities and motor agility, a canonical correlation analysis was applied. The obtained data were processed by means of the statistical package Statistika 7.0.

RESULTS

Table 1. Basic statistical parameters for the evaluation of functional abilities

Variables	N	Mean	Min.	Max.	Std.Dev.	Skewn.	Kurtos.
FMARG	46	3.74	3.37	4.25	5.32	0.542	1.484
FPLPO	46	172.28	156.00	181.00	4.52	0.482	1.304
FVKPL	46	2475.63	2164.00	2670.00	2.25	0.182	2.154

Legend: arithmetic mean (Mean), minimum (Min), maximum (Max), standard deviation (SD), skewness (Skewn.), kurtosis (Kurtos.)

Table 2. Basic statistical parameters for assessing motor agility

Variables	N	Mean	Min.	Max.	Std.Dev.	Skewn.	Kurtos.
MKVT	46	16.74	13.82	19.35	3.35	0.542	1.484
MKUS	46	11.15	8.75	17.27	2.83	0.482	1.304
MOSS	46	13.45	10.90	16.62	4.24	0.263	2.138

Legend: arithmetic mean (Mean), minimum (Min), maximum (Max), standard deviation (SD), skewness (Skewn.), kurtosis (Kurtos.)

In tables 1 and 2 basic statistical parameters of functional abilities (table 1) and motor agility (table 2) are shown. Since the skewness values do not exceed 1.00 it can be concluded that the distributions are normal (symmetric) with all the applied variables from the area of functional abilities and the agility segment from the area of motor abilities. Kurtosis results range below the normal distribution value 2.75, which makes distribution platykurtic or fuzzy.

Table 3. Canonical correlation analysis of functional abilities with motor agility

Discrim.func.	Can.R	Can.R^2	Chi-sqr.	df	P-level
1	.75	.58	53.67	46	.000

Legend: coefficient of canonical corellation (Can.R), coefficient of determination (Can.R^2), Chi-square test (Chi-sqr.), degree of freedom (df.), significance (p- Level)

In table 3, in which only the first statistically significant pair of canonical factors is shown, there is a great correlation (R=.75) between the system of the applied functional variables and the agility segment from the area of motor abilities.This correlation has the appropriate size of coefficient of determination (Can R^2=.58%) that indicates mutual statistically significant impact of both systems of the applied variables. The significance of canonical factor is also confirmed by the high values of Bartlett's chi-square test coefficient (Chi-sqr.= 53.67).

With regard to the size of the coefficient of canonical correlation Can. R and mutual variance Can. R^2, it can be concluded that the results of respondents' motor agility manifest, to a great extent, depending on their functional abilities.

Table 4. Canonical factors of functional abilities

Functional variables	Root 1
FMAR	-.74
FPPO	-.61
FVKP	.57

Upon examining the canonical factors of functional abilities (table 4), it can be observed that the motor agility success factor is best determined by Margaria test (FMARG -.74), to a smaller extent by Pulse frequency after the load test (FPPO-.61) and least by means of Vital lung capacity test (FVKPL .57).

Table 5. Canonical factors of the motor agility dimension

Motor agility variables	Root 1
MKVT	-.62
MKUS	-.78
MOSS	-.52

Canonical factors of agility variables (table 5), indicate that the success factor in agility is best determined by side steps test (MKUS.-78), to a smaller extent by envelope test (MKVT .62) and least by means of the eight with bending test (MOSS .52.).

Table 6. Cross-correlational matrix of functional and agility tests (variables)

Varijable	MKOT	MKUS	MOSS
FMARG	-0.35	-0.38	0.37
FPLPO	-0.44	-0.48	**0.58**
FVKPL	-0.43	0.46	0.47

Based on the results shown in cross-correlational matrix of functional variables and success variables in agility (table 6), a different degree of correlation coefficient can be observed. The greatest correlation is observed between the motoric test the eight with bending(MOSS) and the functional test pulse frequency after the load (FPLPO) (0.58).

DISCUSSION

Analyzing the results shown in tables 4 and 5,which show the relation of canonical correlation of the first canonical factor from the system of functional variables and the first canonical factor from the agility segment from the system of motoric variables, corresponding conclusions are derived. Namely, the respondents who achieved better results in all the applied tests, by means of which the first canonical factor of functional abilities is determined at the same time achieved better results in the tests by means of which the first canonical factor in the agility segment from the area of motor abilities is determined.

It can be seen from the negative marks of the test saturation coefficients: Margaria test (FMARG) and pulse frequency after the load test (FPPO), as well as from the positive mark of vital lung capacity test (FVKP) compared to the first canonical factor which is determined as general functional ability. In this respect, it is clear that the negative, that is, lower results in the tests Margaria (FMARG) and pulse frequency after the load (FPPO) actually better results. Likewise, positive results in FVKP test are clearly better results.

Certainly, this interpretation can be applied to reverse relations which imply that the respondents who achieve better results in motor agility achieve better results in functional ability tests as well.

The research conducted by many other authors (Duraković, 2008; Ćavar, Glibić, i Markota, (2009) on the population of pupils, good-quality athletes, shows similar results of the correlation between functional and motor abilities. In the aforementioned authors' studies, the results obtained by canonical correlation analysis indicate high interconnection between functional abilities and motor agility.

On the basis of the obtained results it can be concluded that determining relations of functional abilities with the results achieved in motor agility, is fundamental and still current, both practical and theoretical problem, which is of great importance not only because of a possibility of forming more rational procedures in training work in Physical Education and sports, a possibility of more optimal orientation and selection of young sports people, but also in the process of planning, control and programming training and effecient monitoring of the development of relevant anthropological features.

CONCLUSION

In a sample of 46 respondents, primary school athletes, aged 11 years ± 6 months, are examined relations between functional abilities and motor agility. Applied parametric statistics showed that results of tests that analyzed the level of functional abilties of the cardiovascular and respiratory systems, have a positive prediction to achieved results of motor agility tests in a statistically significant level (P level = .000).

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RELATIONSHIP BETWEEN PHYSICAL ACTIVITY OF CHILDREN AND CONGNITIVE ABILITIES

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SUMMARY

The aim of the review of the study was to determine the association of physical activity and cognitive abilities of children on the basis of data collected and analyzed works in the period 1998-2008. Search engines that were used for the collection of works are: Google Scholar, Kobson, Pub Med and DOAJ. Works that were taken into consideration included studies where children were healthy, suffered from no illness and were physically active. The target group was children of 6-18 years. Practicing physical activity has a positive impact in achieving better results in tests for checking cognitive abilities.

Keywords: test, success, students

INTRODUCTION

Almost half of the children and youth aged 12-21 does not practice physical activity to the extent that would satisfy their daily needs (USDHHS, 2000). Regular physical exercise leads to a reduction in obesity, improves mental health and locomotor system of children (Strong et al., 2005). The positive impact between doing sports at an early age and in later life (Janz, Dawson, & Mahoney, 2000) is reflected in a reduction of the risks of cardiovascular disease. Professionals from the field of education and health system find that children who play sports perform better in school than children who are physically inactive.

A couple of the researches show a positive impact of physical activity of children and the achievement of a better performance in school or the achievement of greater success on tests of cognitive ability (California Department of Education [CDE] 2001; Maynard, Coonan, Worsley, Dwyer & Baghurst 1987, Shephard et al. 1984; Shephard, LaVallee, Volle, LaBarre, & Beaucage, 1994), while there are studies that indicate that the impact is small (Daley, & Ryan, 2000; Dwyer, Coonan, Leitch, Hetzel, & Baghurst, 1983) or that the relationship is insignificant (Tremblay, Inman, & Williams, 2000). In these studies the exercise of physical activity records positive results in the cognitive abilities of students (Sibley & Etnier, 2003; Coe, Pivarník, Womack, Reeves, & Malina, 2006; Shephard, 1997; Tomporowski, 2003).

Physical training can be defined as any body movement by skeletal muscles that results in energy expenditure (Caspersen, Powell, Christenson, 1985). Physical activity of children is lesser and in the future it aims to further reduce (Stark & Boris, 2007), which will further increase the risk of various diseases (Boreham & Riddoch, 2001). Regular physical activity of children is an extremely important factor in the development, maintenance and strengthening of the level of physical fitness and the acquisition of the habit of lifelong sports playing (Strong et al., 2005). Numerous studies have shown that sports activities increase blood and oxygen flow which affects the neurotransmitter changes, increases the level of endorphin that reduces stress and improves mood (Taras, 2005). Parents as well as the environment have a great degree of influence on the physical activity of their children (Cvetkovic, et al., 2014).

The aim was to determine the association between physically active children with success in school based on collected and analyzed works in the period from 1998 to 2008.

METHODS

The literature search

The literature search was carried out with the help of search engines: Google Scholar, Kobson, Pub Med and DOAJ. In order for the search to be more specific, the following key words were used for finding works: physical activity, academic achievement, students, performance, children. The papers that were published in the period from 1998 to 2008 were taken into consideration. To make the research more complete, we reviewed also the references of all studies that explored the same or similar field.

The selection of works and data collection

The selection of works was done on the basis of several criteria:

1. That the children were physically active
2. That they were actively engaged in some sport, individually or organized
3. That they had not suffered from any illness
4. That the respondents were boys and girls aged 6-18.
5. That for the check of cognitive abilities they did a test in math, language, reading, writing or that their overall success achieved at the end of the school year was overviewed.

The theoretical consideration of the problem

To collect and analyze the collected works we used the descriptive method and theoretical analysis. The study included 14 papers closely-related to physical activity of children and cognitive abilities. The papers have met all the criteria on the basis of which the selection was made.

The researches that has been collected and analyzed are given in Table 1. Each of the researches in this table includes:

1. Study, first author and year of publication
2. The sample of respondents (number, age, gender, country and testing)
3. Experimental treatment (duration of the program, the number of groups, exercise program)
4. The result of exercise

The sample quite varied, the smallest number of respondents was 53 in the survey (Fredericks, Kokot & Krog, 2006) and the largest 11957 in the study (Nelson & Gordon, 2006). All studies investigated the relationship of physical activity and cognitive abilities of the children. Three studies investigated the relation between physical activity and the general success (Coe et al., 2006; Miller et al., 2005; Hanson et al., 1998; Sanders et al., 2000), the relationship between physical activity and achieving success in mathematics and English tests was investigated in 2 studies (Nelson et al., 2006; Dexter et al., 1999). The relationship of physical activity and achieving success in the mathematics and reading test was examined in 4 studies (Eitle et al., 2002; Carlson et al., 2008; Eitle et al., 2005; Stevens et al., 2008), a test of concentration and motor skills was examined in one study (Catering et al., 1999). The relationship of Canadian achievement test and physical activity of children was examined in one study (Ahamed et al., 2006), the ability test for beginners: mathematics, reading and drawing of people was examined in one study (Frederick et al., 2006), while the mathematics test, English test and general achievement test were examined in a study (Daley et al. 2000). The duration of the research varied. The shortest study lasted for 6 weeks in one study (Catering et al., 1999) while the longest study lasted for 5.5 years (Carlson et al. 2008). Most of the research lasted for 2 years, which is enough time to give visible results in the studied relationships of physical activity and cognitive abilities of the children.

The number of groups in studies was variable and ranged from two groups in most studies to four groups in four studies (Eitle et al., 2002; Eitle et al., 2005; Stevens et al., 2008; Sanders et al., 2000), while one study had five groups (Nelson et al., 2006).

Table 1. The relationship between thephysical activity of children and cognitive abilities

Study, first author, year	Sample of respondents					Experimental treatment			
	Nub mber	Age	Ge nde r	Country	Study	Program lasting	The number of groups	Exercise program	The result of exercise
Catering et al. 1999.	54	8-10	Bot h	USA	Concentration and motoric skills test	6 weeks	1) physically active children 2) physically unactive children	15 min, stretching exercises and walking 3x week	Children of 10 years who were physically active in a concentration test showed better results while there was no difference in any of the age in the motor skills test
Nelson et al. 2006.	1195 7	12-18	Bot h	USA	Mathematics and English test	2 years	1) regular PE class 2) active participation in school sports 3) recreation with parents 4) exercising in recreational center 5) children who are not physically active	2x week to 7x week one hour	Students who spend more time doing sports activities achieved better results in math and English tests

Eitle et al. 2002.	5018	15-16	Both	USA	Mathematics and reading test	2 years	1) recreational basketball playing 2) recreational football playing 3) recreational playing of other sports 4) children who do not play any sports	free time	Students who play football or basketball achieved poorer results in tests of mathematics and reading test. Boys (white) who play other sports achieved better results than boys (white) who play football or basketball; and that blacks who play basketball or football or some other sport.
Carlson et al. 2008.	5316	6	Both	USA	Mathematcs and reading test	5.5 years	1) regular PE class 2) less active children	2x week	Girls who were phusically more active in PE class achieved slightly better results in math and reading tests.
Eitle et al. 2005.	10087	13-14	Both	USA	Mathematcs and reading test	2 years	1) children who play baseball/softball 2) children who play basketball 3) children who play football 4) children who play some other team or individual sport	free time	Practicing some other team or individual sports monitors achievement of better results in tests. Students who play baseball / softball or soccer recorded poor results in the tests. Girls (black women) who play baseball / softball recorded poor results in the math test. The students who practiced other sports perform better in tests.
Coe et al. 2006.	214	11	Both	USA	General success at school	11 months	1) children who practive physical activity 3x week 2) children who are not active	3x week	Children who practice physical activity record better general success that the children who are not physically active
Miller et al. 2005.	586	14	Both	USA	General success at school	2 years	1) recreational sports 2) physically insuficiently active	free time	Girls who are engaged in sports recreationally record better general success at school than girls who are not sufficiently physically active.
Stevens et al. 2008.	6482	5-6	Both	USA	Mathematics and reading test	5 years	1) physical activity with parents 2) shaping and strength exercises 3) playing some sport 4) regular activities in PE class	free time nad 2x week	Students who are physically active only in PE class recorded poor results in the math test. Boys and girls who are physically active out of the PE class as well record better results in tests.
Hanson et al. 1998.	123	15-16	Both	USA	General success at school	2 years	1) playing some sport 2) cheerleading	free time	Students who are cheerleaders achieved poor final result at school.
Ahamed et al. 2006.	288	10	Both	Canada	Canadian achievement test	16 months	1) 15 minutes of additional physical exercise after PE class 2) active involvement in PE class	3x week	There was no difference between groups at the final test

Frederick et al. 2006.	53	6-7	Bot h	Africa	Ability test for beginners; mathematics, reading, drawing figures	2 months	1) 10-week program for motor skills development 2) others	3x week	Experimental group achieved better results in tests
Daley et al. 2000.	232	13-16	Bot h	UK	Mathematics, English and general knowledge test	1 year	1) physically active 2) do not do sports	free time	Students who are physically active achieved better results in tests.
Dexter et al. 1999.	217	16	Bot h	UK	English and math test	6 months	1) recreational sports 2) others	free time	Students who are physically active achieved slightly better results in tests.
Sanders et al. 2000.	517	16-18	Bot h	USA	General success at school	1 year	1) slight physical activity, 2 hours a week 2) moderate physical activity, 3-6 hours a week 3) high physical activity 7 hours a week 4) others	free time	Students who practiced a slight, moderate and high physical activity did not achieve better results in tests of overall achievement

DISCUSSION

On the basis of the examined studies we can conclude that the physical activity is closely associated with cognitive abilities. The largest number of studies investigated the association of physical activity of children in their spare time with the achievement of results on tests of cognitive ability. The children who are physically active achieved better results in tests of checking knowledge of mathematics, language and general success, than children who were less physically active or did not practice physical activity. Physical activity which is reflected in a 15-minute stretching and light walking three times a week (Catering et al., 1999) helps to achieve better results in tests of concentration. Children who have practiced physical activity two times to seven times a week with an hour of playing a sport or practicing in the gym, have achieved better results in mathematics and English language tests (Nelson et al., 2006), while one study notes there is no difference in the intensity of physical activities, twice a week to seven times in a week with the achievement of final success at school (Sanders et al., 2000).

In the Study (Eitle et al., 2002) we can see that there is a difference between practicing certain sports and achieving cognitive success. Children who do not play football and basketball but other sports have achieved better results in mathematics and reading tests than children who only play football or basketball. Children who regularly work in PE class (twice a week) achieved slightly better results in mathematics and reading tests than children who are less active (Carlson et al., 2008). Practicing individual or team sports in spare time, that are not baseball / softball or football gives better results in tests of reading and mathematics (Eitle et al. 2005), also in the same study we can see that students - black women playing baseball and softball record worse test results in mathematics and reading. Children who practice physical activity three times a week or do some recreational sports (Coe et al., 2006; Miller et al., 2005) achieve better overall success in school.

There is a difference in achieving success in the mathematics test and reading test between children who are physically active only in PE class and children who have additional physical activity in leisure time, playing some sport or playing with their parents. Children, who are physically active out of the physical education class as well, perform better in tests of mathematics and reading (Stevens et al., 2008).

If under the physical activity we mean cheerleading, it will not produce positive results in the final success in school. Girls who were cheerleaders achieved bed ultimate success at the end of the school year (Hanson et al., 1998). Differences in achievement of the final success at the end of the school year between students who exercised three times a week for fifteen minutes longer after the PE class, and students who were practicing at PE class were not recorded (Ahamed et al., 2006). Research conducted with preschool children (Frederick et al., 2006) recorded that the children who participated in organized exercise program three times a week achieved a better performance in a test of mathematics, reading and drawing figures. Children who have been practicing physical activity in leisure time achieved better results in tests of mathematics, English and general success (Daley et al., 2000; Dexter et al., 1999; Sanders et al., 2000).

All research included the boys and girls of different ages. As the problem of the studies we can point out the lack of description of the activities that were practiced during the experimental treatment and the correct dosage.

CONCLUSION

This study confirms that physical activity has a positive effect on the cognitive abilities of children of all ages. Practicing physical activity of children has a positive impact in achieving better results in tests of mathematics, language, reading, drawing and concentration test. Physical activity that is reflected in the cheerleading does not give positive results in tests.

Continued research should be reflected in the understanding of the causal link between physical fitness and cognitive abilities of the children. Future research should explore which parameters of physical fitness and activities have the greatest impact on cognitive abilities, study the effects of physical activity in groups and investigate which models of tests combine the best and provide the most valid results in the study of cognitive abilities.

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IMPACT OF STATION WORK METHOD ON THE DEVELOPMENT OF MORPHOLOGICAL CHARACTERISTICS AND DYNAMIC STRENGTH IN PRE-PUBERTY PUPILS

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SUMMARY

The sample comprising 60 12-year old pupils from the elementarv school in Nis was devided into the experimental (30) and control (30) group. The research was conducted in order to determine the influence of station work method on the development of morphological characteristics and dynamic strength of the prepuberty period pupils. The experimental treatment was applied in duration of 3 months (36 hours) and was implemented during the main part of the class. The control group had usual physical education classes with the same number of hours. In both groups of subjects, the initial and final measurement of the morphological characteristics (13 anthropometric measures), and dynamic strength (6 variables) were performed. The research

Keywords: Impact of station, morfological characteristics, dynamic strength, pre-puberty pupils

INTRODUCTION

Physical education is essentially a very complex pedagogical-motor transformation process in which the effects are achieved by specific means i.e. physical exercises. Managing this transformation processes is maximally effective if there is a feedback loop, which ensures a steady flow of information from teachers to students, and vice versa. In addition, the development of certain anthropological characteristics in physical education curricula is conditioned by the dynamic and undulating processes characterized by the appropriate quantitative and qualitative indicators. These processes are mainly of the individual character and are in conjunction with the capabilities and characteristics of each student. Each teaching activity or a training process which aims at the development of certain abilities and characteristics of children, among other things, require also specific organizational forms of work on the basis of which in a particular situation one can achieve the best results. Implementation of these organizational forms of work has a particularly important role when we want to overcome the possible poor working conditions and lack of space to exercise.

In this study to determine the effects of work in physical education teaching with the pupils of the pre-puberty age method a **station work** method was used. The aim of this study was to determine how much a station work method contributed to the development of the morphological characteristics and the dynamic power of the sixth grade elementary school pupils. In addition, the objective of the study was to determine the differences between the results obtained through the implementation of the experimental program involving a specially selected group of children and the results of children in the control group who in this study worked exclusively according to the PE curricula proposed by the Ministry of Education of the Republic of Serbia.

METHODS

The population from which the sample of subjects was drawn in this study was defined as a population of the sixth grade primary school "Ratko Vukicevic" in Nis pupils, aged 12 years. (+-6 months). A sample of 60 male subjects involved in this study, was divided into two subsamples, the experimental and control group, each comprising 30 students. For the evaluation of the morphological characteristics following was measured: body height in cm (AVIS), sitting height in cm (ASVT), leg length (ADNG), shoulder width in cm (ASRA), the pelvis width in cm (Asik), the hips width (Aska) , body mass in kg

(AMAS), the outstretched upper arm in cm (AONAD), circumference of forearm in cm (AOPOD), the lower leg volume in cm (AOPOT), forearm skinfold in mm (ACND), abdominal skinfold in mm (AKTR), thigh skinfold in mm (AKNB). (Anthropometric measures were taken on the basis of the research results, the factor structure of the anthropometric measures of Hošek, Stojanović, Momirović, Gredelj, 1981).

To assess the level of dynamic strength a battery of tests of Kurelić et al., 1975 was applied as well as the following measuring instruments to assess the explosive strength: standing long jump (MSDM), standing triple jump (MTRS), ball throwing (MBLP), while for the assessment of the repetitive strength following were used: trunk lifting on the Swedish bench (MDTK), push-ups (MSKLE), squats (MČUČ). Two measurements were performed, at the beginning of the experimental treatment (the initial measurement) and at the end after three months of work (the final measurement). The experimental program was implemented through the station work method with 36 classes within the regular school physical education curricula and it aimed to increase the morphological characteristics and the level of dynamic strength (explosive and repetitive strength) in the experimental group subjects.

The experimental group (30 pupils) has at any moment in the second "B" part (15 min.) performed a special exercise program for the development of dynamic strength drawn up in accordance with the criteria of training work consistent with the pedagogical and physiological characteristics of the children of that age. There were applied known exercises that were derived from the natural body movements except that they were added a special burden. Given that station works were placed so that there were more working positions, the total work was dosed at twenty seconds (20 sec) stay at one station before switching to the other.

In all these stations there were performed exercises for the development of dynamic strength (explosive and repetitive) and the following activities were realized: a) explosive strength in the activities of throwing and thrusting, long and high jumps, kicking and sprinting; b) repetitive strength was mainly assessed in the activities of overcoming the external load (medicine ball, expanders or partner), or in repeated overcoming the weight of one's own body (chin-ups, push-ups, chin-ups mixed).

Station work for back muscles	Station work for leg muscles	Station work for abdomen muscles	Station work for arm and shoulder girdle muscles
BACK STRETCHING	HOPPS	FORWARD BEND	CHIN-UPS

After testing basic descriptive statistical parameters for all morphological characteristics and dynamic strength were calculated. Discrimination of measurements was stated by using two methods: 1) Skewness (SKEW); 2) Kurtosis (KURT);

Canonical discriminant analysis for determining the differences in the final as compared to the initial state between the experimental and the control groups in the morphological characteristics and dynamic strength was used. To determine the differences in the final as compared to the initial measurement between the experimental and the control groups, both a multivariate analysis of variance (MANOVA) and the univariate analysis of variance (ANOVA) were

RESULTS AND DISSCUSION

On the basis of the central and dispersion parameters of the statistical variables in the initial and the final measurements, it can be concluded that both in the experimental and the control group there were no statistically significant changes in morphological characteristics, so one can determine the univariate and discriminative analysis of the obtained results in one and in both groups. The obtained results are shown in Tables 1 and 2.

Table 1. The significance of differences between the initial and final measurement of the anthropometric measures on the univariate level forthe experimental group

ANTHROP. MEASURES	Measurements	N	MEAN	F-relation	P-LEVEL
AVIS	IN	45	150.90	0.71	0.396
	FI	45	153.11		
ASVT	IN	45	77.05	3.48	0.081
	FI	45	77.49		
ADNG AŠIRA	IN	45	84.96	0.25	0.307
	FI	45	86.84		
	IN	45	32.45	3.59	0.096
	FI	45	33.34		
AŠIKA	IN	45	23.16	4.21	0.089
	FI	45	24.33		
AŠIKU	IN	45	25.42	4.33	0.091
	FI	45	26.50		
AMAS	IN	45	40.84	0.40	0.186
	FI	45	40.64		
AONAD	IN	45	20.55	2.73	0.103
	FI	45	22.25		
AOPOD	IN	45	19.84	.236	0.086
	FI	45	20.42		
AOPOT	IN	45	30.64	3.01	1.294
	FI	45	31.40		
AKNNA	IN	45	10.21	2.98	0.040
	FI	45	10.01		
AKNTRB	IN	45	9.86	4.62	0.033
	FI	45	8.30		
AKNBUT	IN	45	15.08	4.50	0.035
	FI	45	14.53		

Table 1 shows the univariate analysis of the variance for the anthropometric measures of somatometric characteristics by comparing the results of the arithmetic means of the experimental group in the final and the initial measurements. Based on the coefficients of F-relations and their significance (P-LEVEL) it can be stated that at the end of the expeirmental period there was no statistically significant increase on the level of significance ($p < 0.05$) in the longitudinal and transversal dimensionality, volume and body mass, except for all measures of the subcutaneous adipose tissue (forearm skinfold thickness AKNNA 0.040, abdominal skinfold AKTRB 0.033, thigh skinfold AKNBUT 0.035).

In this research, a statistically significant reduction in the level of all applied anthropometric measures of skinfolds at the end of the experimental period, under the influence of circuit forms of work, was found. This is so because they are susceptible to external factors and in particular because the tasks at stations were in in the function of reducing the skinfolds thickness.

The research results presented in Table 2 have been determined on the basis of the univariate analysis of variance, by comparing the results of the arithmetic means of the anthropometric measures of the control group in the final and the initial measurements. Results of the coefficients F-relations and its significance level of P-LEVEL at the level $P < 0.05$ indicates that in the end of the experimental period, there was no statistically significant increase in the anthropometric measures. It is only in the dimension of the subcutaneous adipose tissue, in the anthropometric measure abdominal skinfold (AKNTRB 0046), noticeable the occurrence of the skinfold thickness reducing.

The reasons for the reduction of the abdominal skinfold thickness can be numerous, but is most likely that the reduction was caused by the of use of different means of physical exercising during physical education teaching process, or the training process in subjects who actively participate in sports because they were subjected in the course of work with them, to the repetitive strength of the abdominal muscles exercises. Accordingly, Jukic et al. (2003) suggest that *it is impossible to influence through the training processes the longitudinal and transversal dimensionalities of the skeleton, but it is however, possible to influence the optimization of the volume of the muscle mass and the subcutaneous adipose tissue in accordance with the requirements of a particular sport.*

Table 2. The significance of differences between the initial and final measurement of the anthropometric measures on the univariate level forthe control group

ANTHROP. MEASURES	Measurements	N	MEAN	F-relation	P-LEVEL
AVIS	IN	45	150.90	0.63	0.371
	FI	45	152.42		
ASVT	IN	45	78.06	3.76	0.093
	FI	45	78.80		
ADNG	IN	45	84.96	0.46	0.298
	FI	45	86.03		
AŠIRA	IN	45	32.45	4.50	0.082
	FI	45	33.37		
AŠIKA	IN	45	23.16	5.49	0.070
	FI	45	24.06		
AŠIKU	IN	45	25.42	5.31	0.172
	FI	45	26.24		
AMAS	IN	45	40.84	0.62	0.181
	FI	45	43.20		
AONAD	IN	45	20.55	3.31	0.202
	FI	45	21.63		
AOPOD	IN	45	19.84	3.05	0.080
	FI	45	20.86		
AOPOT	IN	45	30.64	3.81	1.32
	FI	45	31.73		
AKNNA	IN	45	10.93	5.92	1.56
	FI	45	10.75		
AKNTRB	IN	45	8.78	4.31	0.046
	FI	45	8.94		
AKNBUT	IN	45	15.08	5.42	1.63
	FI	45	15.19		

In the dynamic strength there has been a statistically significant increase in the level of the dynamic strength in the experimental group pupils both in the multivariate and the univariate levels, which are determined by the variables standing long jump (MSDM 0.016), standing triple jump (MTRS 0.045), push-ups (MSKLE 0.020) and squats (MčuČ 0.036), as can be seen from the Tables 3 and 4.

A statistically significant increase in the dynamic strength (Q = 0.05), defined by the dimensions of the explosive and repetitive strength in the experimental group, probably is the result of the proper organization and realization of the experimental treatment by using a circuit method of work. The increase in the dynamic strengthth was brought about also because the subjects have properly performed their exercises on stations to develop their explosive strength. Likewise, the subjects have implemented their tasks with the maximum vigour and strength in the shortest possible period of time, although the factor of the inherent explosive strength according to Fleishman is very high (0.80). In addition, a repetitive strength, which characterises the ability of a long-term work, was likely achieved by the proper volume of the work load, since it is known that its development is most optimal when the load is overcome by 75% in relation to the maximum intensity, which certainly was present in the experimental group subjects.

In the control group in the end of the experimental period, there was a statistically significant increase in the dimensions of the dynamic strength which are defined by the variables trunk lifting on the Swedish bench (MDTK 0.046) and push-ups (MSKLE 0.037).

Table 3. The significance of differences between the initial and final measurement of the dynamic strength tests on the multivariate level forthe experimental group

WILK'S LAMBDA TEST	0.563
RAO F-approximation	0.722
Q	**0.005**

Table 4. The significance of differences between the initial and final measurement of the dynamic strength tests on the univariate level forthe experimental group

VARIABLES	Measurements	N	MEAN	F-relation	P-LEVEL
MSDM	IN	45	162.95	13.60	0.016
	FI	45	178.73		
MTRS	IN	45	5.104	19.04	0.045
	FI	45	5.242		
MBLP	IN	45	2.391	3.32	0.068
	FI	45	3.080		
MDTK	IN	45	6.66	2.30	0.094
	FI	45	10.08		
MSKL	IN	45	5.60	6.11	0.020
	FI	45	8.62		
MČUČ	IN	45	14.75	1.32	0.036
	FI	45	19.42		

Table 5. The significance of differences between the initial and final measurement of the dynamic strength tests on the multivariate level forthe control group

WILK"S LAMBDA TEST	1.89
RAO F-approximation	31.261
Q	**0.042**

Table 6. The significance of differences between the initial and final measurement of the dynamic strength tests on the univariate level forthe control group

VARIABLES	Measurements	N	MEAN	F-relation	P-LEVEL
MSDM	IN	45	160.55	17.22	0.101
	FI	45	165.60		
MTRS	IN	45	4.962	24.03	0.122
	FI	45	5.002		
MBLP	IN	45	2.322	5.36	0.061
	FI	45	2.440		
MDTK	IN	45	6.24	5.00	**0.046**
	FI	45	7.84		
MSKL	IN	45	4.73	9.02	**0.037**
	FI	45	6.00		
MČUČ	IN	45	14.22	2.43	0.086
	FI	45	15.22		

Basketball, as it is known, is dominated by an explosive and repetitive strength as compared to the other dimensions of the motor space, with shorter breaks or the interval character, when it comes to complete exhaustion of the energy resources. It is this very exhaustion of the energy reserves in the shorter intervals that has affected the control group subjects to increase the level of the dynamic strength. This explanation states Philipp (1999), who found out that the complete exhaustion of the energy reserves is more efficient than multiple quasi complete exhaustion. In this way the body gets a stronger development stimulus in the smaller total power consumption.

The emergence of statistically significant influence of the physical education curricula contents on the dynamic strength in the control group (Q = 0.042) was certainly due to the realization of program tasks in the basketball class that dominated the time of the experimental treatment exercises. In basketball, as it is known, is dominated by the explosive and repetitive strength compared to the other dimensions of the motor space, with shorter intervals intevalnog character, when it came to filling and exhaustion of energy resources. It fully discharge energy reserves at shorter intervals affected the control group to increase the level of dynamic power. This explanation states Philipp (1999), who found that the complete emptying of energy reserves more efficiently than multiple quasi complete exhaustion. In this way the body gets stronger development stimulus in the total power consumption.

Tabela 7. Summative overview of the significance of the multivariate and univariate analyses of the variance for the experimental and the control group

MORPHOLOGICAL CHARACTERISTICS			
EXPERIMENTAL GROUP		CONTROL	GROUP
Multivariate significance	Q=0.071	Multivariate significance	Q=0.081
Univariate significance	AKNNA 0.040 AKNTRB 0.033 AKNBUT 0.035	Univariate significance	AKNTRB 0.046
DYNAMIC STRENGTH			
EXPERIMENTAL GROUP		CONTROL	GROUP
Multivariate significance	Q=0.005	Multivariate significance	Q=0.042
Univariate significance	MSDM 0.016 MTRS 0.045 MSCL 0.020 MČUČ 0.036	Univariate significance	MDTK 0.046 MSKL 0.037

Table 7 provides a summative overview of the significance of the multivariate and univariate analyses of the variance for the experimental and control groups, which shows that there has been the statistically significant differences in the dynamic strength between the experimental and the control group subjects, but only in four (4) tests, while in the control group, this significance was observed only in two (2) tests.

CONCLUSION

1.On a random sample of 60 male primary school pupils in Nis aged 12, divided into the experimental and control group, a longitudinal study was conducted in order to determine the influence of the experimental program, that is station work, on the development of the morphological characteristics and the dynamic strength of the prepuberty age schoolchildren.

2. Subject of the research study was the station work method, the area of the morphological characteristics and the dynamic strength of the sixth grade primary scoool students.

3.Research problem was to analyze the effects of the experimental program using the station work method in the experimental group subjects, to increase the level of the anthropological characteristics.

4. The experimental treatment lasted for three months (36 hours) and was achieved mainly in the B part of the PE class. The controln group had during that time classical physical education classes with the same number of hours. In both groups of subjects

there was performed the initial and the final measurements of the morphological characteristics (applying 13 measuring instruments) and dynamic strength (six tests). The research results in both groups were determmined by the multivariate analysis of variance and discriminant analysis.

5.Under the influence of the experimental treatment and work on the development of the morphological characteristics in the pupils of the experimental group, using programmed instruction and the station work methods, there was no significant increase on the multivariate level, therefore, the assumed hypothesis H1 cannot be completely accepted. At the univariate level (P-level) in the end of the experimental period, there was a statistically significant reduction in the subcutaneous adipose tissue in all measured parameters so that for these measures a hypothesis H1 is accepted, and for all the other measures, is rejected.

6.The applied work program of the regular physical education classes (control group) did not statistically significantly affect the increase in morphological characteristics on the multivariate level, therefore it follows that the the hypothesis H2 cannot be fully accepted. Ot the univariate level (P-level) in the final as compared to the initial state there was established a statistically significant reduction in subcutaneous adipose tissue in the abdomen skinfold (AKNTRB 0.046) and for this measure a hypothesis H2 is accepted.

7. With regard to the development of the dynamic strength under the influence of the experimental treatment and using the station work methods, there was a statistically significant increase on the multivariate level (Q = 0.005), therefore, the set hypothesis H7 can be accepted. On the univariate level, P-LEVEL, in the end of the experimental examination, there was an increase in the dynamic strength with the variable standing long jump, standing triple jump, push-ups and squats, so for these variables a hypothesis H7 can be accepted, and for the rest is rejected.

8. Regular physical education classes in the control group showed a statistically significant increase on the multivariate level (Q = 0.042), therefore, a set hypothesis H8 can be accepted. On the univariate level, there has also been a statistically significant increase in the dynamic strength when trunk lifting on a Swidish bench and push-ups, so for these variables a hypothesis H8 can be accepted, and for the rest rejected.

The generalization of the obtained results in this study primarily refers to the population of the primary school pupils who have the same, or approximately the same physical and psychological characteristics, as the subjects investigated in this study. We believe that the experiment was successful because the obtained results show that the circuit method of work has indeed statistically significantly effect a large number of parameters, which is of great importance for both theory and practice.

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IMPACT OF SELECTED SPORTS VOLLEYBALL AND BASKETBALL ON THE DEVELOPMENT OF SPEED, STRENGTH AND AGILITY IN THE SEVENTH GRADE PRIMARY SCHOOL FEMALE PUPILS

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SUMMARY

On a sample of the seventh grade primary school female pupils N = 48 of the primary schools Vuk Karadzic and 9 Maj in Presevo, divided into two parallel experimental groups (E1 and E2), within the physical education curriculum there were implemented experimental programs in Volleyball and Basketball, as selected sports. Within the pedagogical experiment lasting one school semester, there were applied two morphological and 12 motor variables in the areas of speed, explosive and repetitive strength and agility. The obtained results, after statistical data processing, show that there are no differences in the final measuring in the improvement of speed, strength and agility, as the investigated motor abilities, within the realized experimental programs in Volleyball and Basketball as sports selected by pupils. In this way, it was proved that equal effects were achieved by using two different chosen sports.

Keywords: Selected sports, Volleyball, Basketball, Motor Abilities

INTRODUCTION

Physical education curriculum has not yet produced the expected effects. Based on the information obtained about the character and quality of the school physical education, it can be concluded that not only is it not sufficiently oriented to the systematic and comprehensive physical exercising, but it also lacks the appropriate intensity of exercise, that would cause stimulant and effective development of the pupils physical abilities. Poor effects of such designed teaching process has influenced the search for better solutions. One of the possible solutions that would contribute to the development of speed, strength and agility, is the implementation of the experimental program of the selected sports - Volleyball and Basketball in seventh grade primary school female pupils.

In order to improve teaching process a legislator has in the Law of primary education of the Republic of Serbia prescribed that from the fourth to the eighth grade of the primary school, physical education classes should be implemented beside the two-hour framework of regular classes also with one class a week, according to a special teachers' program, of the selected sport as a pupil's choice. Only by integral action using training methods of developing physical qualities and abilities, through the experimental program of selected sports Volleyball / Basketball and other activities, can greater efficiency of physical education teaching process be achieved. The research subject of this paper is to check the impact of the programmed process of volleyball and basketball training as selected sports in the seventh grade primary school pupils. Physical education curriculum poses development of motor skills not only as a result of physical activity, but also as the immediate objective of PE teaching and its basic task.

Performing physical exercises in the classroom is one form of facing students with their environment (space and facilities) and time in the process of teaching. Physical activities in teaching process can be viewed as a means of formation of motor habits and sports techniques, and on the other hand, as a means of motor skills developing. Motor abilities of pupils depend mainly on the morphological characteristics: body weight, height, subcutaneous fat and other characteristics. Teaching methods of the so-called school type with dominant content in the training phase and the minimum practical coaching, insufficient teaching hours, insufficient intensity and density of the teaching process, poor motivation and material conditions do not provide an opportunity for the pupils to comprehensively develop their motor and physical skills.

The basic objective of this study was to determine the impact of the planned program in Volleyball and Basketball as selected sports on speed, power and agility of the pupils.

METHODS

Research subject are motor abilities of girls, i.e. speed, strength and agility, and selected sports Volleyball and Basketball, that is, determining differences in the investigated motor skills under the influence of the selected sports Volleyball and Basketball in seventh grade primary school female pupils.

Research problem is to examine whether seventh grade primary school female pupils of the experimental group (E1) achieve greater or lesser value results in motor skills as compared to the experimental group (E2). Also, the problem of this research is the optimization of the selected programs of Volleyball and Basketball in the physical education class in terms of its operational efficiency, defined as the ability of the program of the selected sports Volleyball and Basketball to influence the development of speed, strength and agility of the seventh grade primary school "Vuk Karadzic" and "9. maj " female pupils in Presevo.

Research objective

On the basis of the research subject and problem, the goal is to determine the impact of the selected program of Volleyball and Basketball on the development of speed, strength and agility of the seventh grade abovementioned primary schools female pupils in Presevo.

Research Tasks

Based on the above problem and stated objectives of research the following tasks are defined:

- To determine the level of motor skills - speed, power and agility of the experimental group (E1 Volleyball) in the seventh grade primary school female pupils in the initial and final measurements;
- To determine the level of motor skills of - speed, power and agility of the experimental group (E2 Basketball) in) in the seventh grade primary school female pupils in the initial and final measurements;
- To determine the differences in speed, strength and agility of the experimental groups (E1 and E2) in girls in the initial testing;
- To determine the differences in speed, strength and agility in the experimental groups (E1 and E2) in girls in the final testing.

Based on the research object and problem and in accordance with the objective and statistical methods for data processing, following hypotheses can be set:

- **H1-** there are no statistically significant differences in speed between the experimental group (E1) and (E2) in the seventh grade primary school female pupils, in the initial measurement.
- **H2-** there are statistically significant differences in speed between the experimental group (E1) and (E2) in the seventh grade primary school female pupils, in the final measurement.
- **H3-** there are no statistically significant differences in strength between the experimental group (E1) and (E2) in the seventh grade primary school female pupils, in the initial measurement.
- **H4-** there are statistically significant differences in strength between the experimental group (E1) and (E2) in the seventh grade primary school female pupils, in the final measurement.
- **H5-** there are no statistically significant differences in agility between the experimental group (E1) and (E2) in the seventh grade primary school female pupils, in the initial measurement.
- **H6-** there are statistically significant differences in agility between the experimental group (E1) and (E2) in the seventh grade primary school female pupils, in the final measurement.

This study applied a type of pedagogical experiment with parallel groups lasting for one school term. The experimental factor is specially programmed physical education teaching process, in which Volleyball and Basketball are PE means that solve certain tasks with a priority role.

SUBJECT SAMPLE

The subject sample includes a student population of boys and girls of the seventh grade elementary school "Vuk Karadzic" and "9. maj " in Presevo. The survey was conducted on a final sample of 48 female subjects. It is a convenient sample, divided into two parallel experimental groups. The first experimental group (E1) comprised 24 subjects who in addition to the regular physical education program also attended classes of the chosen sport of Volleyball (18 hours), and a second experimental group (E2) consisting of 24 female pupils who in addition to regular physical education program chose Basketball, with the same number of classes.

Subjects	Volleyball E1	Basketball E2
girls	24	24
Total pupils	48	

VARIABLE SAMPLE

The sample of variables consisted of a set of two variables of physical development (body height and body mass) and 12 variables applied to examine by speed, strength and agility of the female pupils.

Morphological characteristics:
1. Body height (MTV)
2. Body mass (MTT)

Motor abilities:

Speed
1. 10 m running (MT10M),
2. 20 m running (MT20M),
3. 30 m running (MT30M).

Explosive strength
4. Squat jump (MSČ),
5. Counterclockwise jump (MSSK),
6. Deep jump (MSD).

Repetitive strength:
7. Pull-ups to failure (MZGB),
8. Push-ups (MSKL),
9. Trunk lift (MDTR).

Agility
10. 20 yard (18.3 m.) running (MT20J),
11. 505 agility test (MTA505),
12. Zig zag (M33).

* Test descriptions can be accessed from the author.

Physical education classes contents (2 classes a week)

Class (period) structure

Class structure for both experimental groups is four-part with standardized content:

1. Standardized content for the introductory phase of class, 4-5 minutes,
2. Standardized content for the preparatory phase of class,
3. The main stages of the class have included contents from athletics, floor and apparatus exercises and dance with a total number of 36 classes in one school semester,
4. Content of the final stage of class was tailored to the immediate needs of the pupils in the concrete conditions of the class duration.

Work program – selected sport Volleyball (1 class a week)

Class (period) structure

Class structure for both experimental groups is four-part with standardized content:

1. Standardized content for the introductory phase of class, 4-5 minutes,
2. Standardized content for the preparatory phase of class,
3. The main stages of the class including contents of the experimental program in Volleyball,
4. Content of the final stage of class was tailored to the immediate needs of the pupils in the concrete conditions of the class duration.

Class main phase contents of the selected sport Volleyball

At the beginning of the school year, the curriculum involves the content of the program for the chosen sport of Volleyball. Experimental procedure for the chosen sport of Volleyball was conducted in the main part of the class thus providing 18 classes of the experimental program.

The contents of this experimental program that was implemented in the experiment can be obtained from the authors.

Work program – selected sport Basketball (1 class a week)

Class (period) structure

Class structure for both experimental groups is four-part with standardized content:

1. Standardized content for the introductory phase of class,
2. Standardized content for the preparatory phase of class,
3. The main stages of the class including contents in Volleyball,
4. Content of the final stage of class was tailored to the immediate needs of the pupils in the concrete conditions of the class duration.

Class main phase contents of the selected sport Basketball.

At the beginning of the school year, the curriculum involves the content of the program for the chosen sport of Basketball within the regular teaching process in the chosen sport. Experimental procedure for the chosen sport of Basketball was conducted in the main part of the class.

Statistical analysis Methods of data analysis in order to reach scientific data in this study included descriptive statistics, univariate and mutivariate statistical methods and analysis of the results in testing research hypotheses.

RESULTS AND DISCUSSION

The obtained results of the significance of differences of the arithmetic means for schoolgirls (Basketball and Volleyball) at the initial and final measurements between the experimental groups (E1 and E2) for the variables: speed, strength and agility, are presented in the following six Tables.

1. The significance of differences of the arithmetic means for schoolgirls (Basketball and Volleyball) in the initial measurement for the speed variable

Multivariate Tests[b,c]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Gr	Wilks' Lambda	.985	.157[a]	3.000	32.000	**.924**

2. The significance of differences of the arithmetic means for schoolgirls (Basketball and Volleyball) in the final measurement for the speed variable

Multivariate Tests[b,c]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Gr	Wilks' Lambda	.980	.220[a]	3.000	32.000	**.882**

3. The significance of differences of the arithmetic means for schoolgirls (Basketball and Volleyball) in the initial measurement for the strength variable

Multivariate Tests[b,c]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Gr	Wilks' Lambda	.817	1.085[a]	6.000	29.000	**.395**

4. The significance of differences of the arithmetic means for schoolgirls (Basketball and Volleyball) in the final measurement for the strength variable

Multivariate Tests[b,c]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Gr	Wilks' Lambda	.767	1.470[a]	6.000	29.000	**.223**

5. The significance of differences of the arithmetic means for schoolgirls (Basketball and Volleyball) in the initial measurement for the agility variable.

Multivariate Tests[b,c]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Gr	Wilks' Lambda	.909	1.069[a]	3.000	32.000	**.376**

6. The significance of differences of the arithmetic means for schoolgirls (Basketball and Volleyball) in the final measurement for the agility variable.

Multivariate Tests[b,c]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Gr	Wilks' Lambda	.972	.304[a]	3.000	32.000	**.822**

From Tables 1 to 6 it can be concluded that there are no statistically significant differences of the arithmetic means for the results of the applied tests for the assessment of speed, strength and agility, in the initial measurement between E1 and E2 groups, and the final measurement between the two experimental groups of female pupils, as well. The significance in the Tables ranged from .924 to .376 in the initial measurement and .882 to .223 in the final measurements. Numerical differences in arithmetic means do exist but they are not on the level of significance of .05.

CONCLUSION

Realized experimental program of Volleyball and Basketball as selected sports in physical education classes in the seventh grade female pupils of the elementary school "Vuk Karadzic" and "9. maj " in Presevo, showed that there are no differences in the development of speed, strength and agility as the investigated motor skills, under the influence of the two programs of Volleyball and Basketball, sports selected by the pupils, in physical education teaching. Therefore, hypotheses H1, H3 and H5 are accepted because there are no significant differences in the initial measurements between the experimental groups, and hypotheses H2, H4 and H6 are not verified because there were no statistically significant differences in the final measurement in the investigated motor skills. Generally speaking, the same effects were achieved by the Volleyball and Basketball program in the investigated motor skills, so none of the experimental programs is preferred.

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BACK MUSCLES FORCE IMPACT ON SWIMMING VELOCITY IN HIGH SCHOOL STUDENTS

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SUMMARY

The aim of this study was to determine the impact of back muscle force on the 50 meters front crawl swim style results among high school students. The sample consisted of 30 subjects aged 15 to 18 who are recreational members of two swimming club in Nis, for a period longer than two years. The sample of variables consisted of four variables to estimate power of back muscles. As a criterion variable the result of swimming in the 50 meter freestyle was used. Results of regression analysis showed that all observed and applied variables for power of back muscles have a significant impact on 50 meters swimming result, together and separately, amoung this group. Based on these results, it can be concluded that the strength of back muscles is an important factor for success in swimming and that is necessary for training process to include dry and water exercise for back muscles strengthening.

Keywords: Impact, Strength of the back muscles, High school students, Freestyle

INTRODUCTION

From history it has been known that man was using different swimming techniques as solution for crossing water obstacles. It is interesting that most of mammals do not need to learn how to swim, and that the man is one of the rear being that needs to learn it. The reason for that would be that the animals are simply repeating the movement from dry land, and that is the same they are doing in the water, i.e., dog. Man on the other side can not repeat his upright standing position for walking, he needs to use arms and breathe properly (Tomić, 2013).

In sport, term strength is regard as ability of muscle to develop specific strain (Nićin, 2000). That strain in physics is called force. This term is not sufficient to explain all specificity which is included during muscle contraction, so in this case we will use terminology that is entrenched in sport

Strength is considering as important factor in swimming (Shionoya et. al., 2001; Garrido et. al., 2005; Trinity et. al., 2006). Authors are citing today the importance of strength training because strength needs to provide specific physical willingness of swimmers for helping them in reaching high sports achievements (Rašović et. al., 2011). Strength with force in swimming is a reliable factor of velocity, especially in freestyle (D'Acquisto & Costill, 1998; Hawley & Williams, 1991; Seifert et. al., 2010; Sharp, 1986; Shimonagata et. al., 2002). In addition, strength training needs to be included in micro, mezzo and macro cycles in multiyear training plan (Rašović et. al., 2011).

For this research is important to describe the period of speed development and strength at the middle school age (15-18 years). This period of development is characterized by uneven development of certain motor skills, where some are rapidly developing, followed by periods of slower growth or stagnation. In the literature, these periods are called sensitive (Radivojevic, 2013). Sensitive periods are specific time phases in which certain dimensions within the motor space increasingly feel the effect of programmed forms of physical exercise (Trunić, 2007). Some authors believe that the sensitive period for the strength is from 12-13 years to 18 years (Winter, 1985). Depending on gender, for boys most muscle mass growth occurs from 13 to 15 years, while the rapid development of maximum strength and other forms of strength occurs from 14 to 15 years (Vorontsov, 2005). Period after puberty that occurs for boys between 16th and 19th year, is characteristic by slow growth (Vorontsov, 2010). Understanding is that excessive efforts can slow bone growth in length and lead to a slowdown of physical and sexual maturation (Đurašković, 2002). Especially during this period, when there is a large difference in motor maturation among boys in height, strength muscle mass, aerobic and anaerobic endurance trainers need to be careful (Vorontsov, 2010). As for velocity, for boys development happens from 5-18 years, while some research show rapid grow after 13th years of age (Malina et. al., 2004).

METHODS

In every sport, including swimming, people have always searched for ways that will lead to better results. These efforts have had its basis in the rich experience of swimming coaches. In recent years, the application of scientific methods and complex understanding of sporting activities play a crucial role in achieving the best results.

Subject of this research represent high school students, age 15-18 years ± 6 months, studying their back muscle strength and swimming velocity. The research problem consisted in finding, establishing and checking connections between back muscle strength and swimming velocity. Respectively, in what way strength of the back muscles affects the swimming velocity at a certain distance. In this research, the goal was to determine magnitude of back force impact on swimming velocity in 50m freestyle in male high school students 15 to 18 years of age. Based on subject, problem and goal of this research, three tasks have been established: to determine back muscle force levels; to determine velocity in 50m freestyle; to determine influence of back muscle force on swimming velocity in 50m freestyle.

Subjects

Participant sample was consisted from 30 healthy males, age from 15 to 18 years. Investigated students were from two swimming sport clubs from city of Nis where they had at least two years of recreational experience (they did not compete professionally).

Procedure

Measuring of muscle force was performed during isometric muscle contraction with dynamometer (IMADA Z2H-1100-Japan) which consisted from special cells with power up to 5000N and with sensibility of 1.25N. Conversion of ratio force / time was assessed with frequency of 1KHZ, then all the data from the initial force of muscle contraction to the maximum value was taken, and then loaded in hardware - software system (WinWedge 3.4, TAL Technologies, Philadelphia, PA, USA) (Beretić, Đurović, Okičić, & Dopsaj, 2013). After standard basic warm-up phase, the subjects performed each test twice with a 2-minute rest between the trials. The evaluation of beck muscles was made by the following procedure: the athlete stands on the platform, holding the dynamometer connected with the platform in front and high up to one third of thighs, with back slightly bent forward, the arms remain straight, the feet are in parallel position and as wide apart as to align with the shoulder width, the legs are in semi-squat position at approximately 120 degrees. On hearing the signal, the athlete executes maximal voluntary isometric contraction of the observed muscle group in order to extending the knees as much as possible for 5 seconds, maintaining his body in the same position, with no movements made in front and lateral planes (Dopsaj et al., 2010; McMguian et al., 2008). Further analysis took into account the more successful trial, i.e. the trial in which the greater maximum force was achieved in the specified test.

Two varable were obtained for back muscle force, medium absolute back force (SASL) and maximal absolute back force (MASL), while medium relative back force (SRSL) and maximal relative back force (MRSL) were calculated with mathematic formula (Stojiljković, 2003).

Measuring of time for swimming velocity in 50m freestyle was performed with stopwatch and it was presented with variable (V50K).

Statistical analysis

For statistical analysis of data statistical program "*SPSS 22*" was used. To determine the levels of investigated force in manifest space with swimming velocity basic statistical parameters were applied: arithmetic mean (Mean), minimum (Min) and maximum (Max) score, range (Range), standard deviation (SD), symmetrical distribution of results (Skewness) and elongation distribution of results (Kurtosis).

Regression analysis was used to determine the influence of back muscle strength on swimming results. Regression analysis was consisted from these parameters: correlation coefficient (R); partial correlation coefficient (Part R); standardized partial regression coefficient (Beta) standard error of the partial regression coefficient (Std. Err. of Beta); the size of the F-ratio (F); t-test (t) and statistical significance (p). For statistical significance, significance level to 0.05 ($p \leq 0.05$) was used (Bala, 1990).

RESULTS

Table 1: Descriptive statistic for swimming 50m freestyle.

	Valid N	Mean	Minimum	Maximum	Range	Std.Dev.	Skewness	Kurtosis
V50K	30.00	33.97	26.54	39.54	13.00	4.06	-0.41	-1.11

Table 2: Descriptive statistic for back muscle strength.

	Valid N	Mean	Minimum	Maximum	Range	Std.Dev.	Skewness	Kurtosis
SASL	30.00	736.30	364.00	1,142.90	778.90	238.74	0.52	-0.96
MASL	30.00	1,106.90	305.20	2,003.00	1,697.80	406.37	0.05	0.04
SRSL	30.00	10.60	5.84	16.60	10.70	3.13	0.58	-0.91
MRSL	30.00	16.00	4.88	28.60	23.70	5.55	-0.08	0.09

Table 3: Regression analyses of back muscle strength.

	Beta	Std.Err. of beta	part-r	r	t(21)	p-level
SASL	0.15	0.06	0.44	0.39	2.46	0.02*
MASL	-0.10	0.04	-0.47	-0.41	-2.63	0.01*
SRSL	-9.77	3.93	-0.45	-0.39	-2.48	0.02*
MRSL	6.13	2.42	0.45	0.40	2.53	0.02*
$R = .62$ $R^2 = .38$ $F(4,25) = 3.85$ $p < 0.01$						

* represents statistical value on level 0.05 (95%)

DISCUSSION

The analysis of Table 1, which presents the main statistical parameters of the velocity in swimming 50m freestyle style, it can be concluded that the results are quite good, and comparing the values in the intervals of the minimum (MIN) and maximum (MAX) results are from 3 to 5 standard deviation (Std . Deviation) which indicates that the results are reliable and that can be used for further analysis (Dopsaj & Bratuša, 2003). Skewness value ranges within normal limits. Kurtosis value in the instant case shows that there was a normal distribution of results and that the swimming test was equal toughness for all the participants indicating homogeneity of the group.

The analysis of Table 2, which presents the main statistical parameters of all applied back muscles forces, it can be concluded that the results are quite good, and comparing the values in the intervals of the minimum (MIN) and maximum (MAX) results are from 3 to 5 standard deviation (Std . Deviation) which indicates that the results are reliable and that can be used for further analysis (Dopsaj & Bratuša, 2003). Skewness value ranges within normal limits. Kurtosis value in the instant case shows that there was a normal distribution of results.

The whole set of applied back muscle force gave the statistical significance **$p < 0.01$** with swimming velocity in 50m freestyle style among high school students, where R is 0.62, a common variance (R^2) explained with 0.38%, which means that the back muscle force variables with 38% explained a result of swimming in 50m freestyle style in this group of students, while the remaining 62% belong to other anthropological areas (motor, functional, etc.). Individually all the back muscle force variables showed a statistical significance and influence with swimming velocity in 50m freestyle style (SASL, SRSL, MRSL $p = 0.02$; and MASL $p = 0.01$). Based on these results it can be concluded that the forces of the back muscles have a huge impact on the swimming velocity in 50m freestyle in this group of participants. These results also show that applied tests for back strength assessment have a big prediction in swimming which can be explained by strong connection between upper and lower limbs that requires a strong back (Einarsson et. al., 2010). In front-crawl, about 90% of the total propulsive force is generated by the arm stroke, the role of the legs is restricted to maintain the body in a proper posture in the water, and that can only be done by reducing the trunk inclination which requires a strong back (Hawley et al., 1992; Deschodt et al., 1999; Gourgoulis et al., 2014) (Dalamitros, Manou & Pelarigo, 2014).

CONCLUSION

In this research goal came from subject of the research and it was to determine magnitude of back muscle force impact on swimming velocity in 50m freestyle. For establishing back muscle force few tasks were needed to be completed: to determine back muscle strength levels; to determine velocity in 50m freestyle; and to determine influence of back muscle force on swimming velocity in 50m freestyle. Results have showed that there is a statistical significance between back muscle force and swimming velocity in 50m freestyle for all of the applied back muscle variables together, and their influence on swimming separately. It can be concluded that back strengthening exercises should be included in water and dry land training.

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NTC METHOD IMPLEMENTATION IN THE DEVELOPMENT OF EARLY MOTOR ABILITIES

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SUMMARY

The improvement of motor abilities of children from 2 to 4 years of age was assessed in two kindergartens in Kranj, Slovenia. As part of the physical activities following the regular kindergarten curriculum, experimental group had incorporated elements from the NTC program, while the control group was engaged in regular physical activities. Incorporated activities of the experimental group are elements from the first phase of the NTC program which are based on complex motor activities (fine motor skills, dynamic eye accommodation, rotation, balance, movement). Prior to the Program implementation, initial testing of both groups was done. Successfulness of following exercise performances was assessed: walking on a line – forward, walking on a line – backwards, long jump - forward, long jump - backward, and squats. After two months period the same testing was done. Final assessment showed an evident improvement of the children in the NTC group. Significant statistical difference was observed for the exercises of walking on a line – forward, walking on a line – backwards, long jump backward, and squats in the NTC control group. Even though the NTC group exhibited less physical agility prior to the Program implementation, the improvement of this group was greater as measured by final assessment. Average number of successfully performed exercises at the beginning of the research in the control group was 3 (SD = 1.7), whereas in the NTC group it was 1.5 (SD 1.4). Average number of successfully performed exercises at the end of the research in the control group was 3.3 (SD 1.6), whereas in the NTC group it was 4.5 (SD 0.7). We conclude that the NTC program implementation in the period of two months showed significant improvement of studied motor abilities in children from 2 to 4 years of age. Further research would need to be done in order to determine whether this relatively short period of the NTC's first phase implementation has a long term effect on child's motor abilities.

Keywords: NTC program, early stimulation, motor abilities

INTRODUCTION

In the last few years, in the regions of East-Central Europe, evident number of children with developmental difficulties emerged. During 2011 and 2012 studies were conducted in Bosnia and Herzegovina, Slovenia, Italy, Montenegro and Serbia. Results showed that more than a half of examined preschool children had flat feet and fine motor skills disorder (Rajović et al., 2014). Additionally, 40% of examined children exhibited eye-hand coordination disorder. The number of such children is on the rise, and the genetic influence could hardly be the main explanation. For the possible cause of these developmental difficulties, improperly developed brain regions, more precisely unoptimal connectedness between the neurons could be to blame. This is extremely important, if we take into consideration that cognitive and therefore intellectual abilities, among others, depend on the overall number of synaptic connections. If we look at a simple analogy, living beings that do not move don't have nerve cells and nervous system, and species that move have a nervous system, then it is clear that one of the important characteristics of people is upright gait and movement. This is particularly important for children, because most of the brain development occurs until the age of five (Rajovic, 2009), and therefor walking and running should be among the main activities in early childhood (Rajovic, 2010). Basal ganglia are not only important for motor control but these structures also contribute to a variety of cognitive functions, such as learning, memory, and planning (Aron et al. 2009). It has been shown that childhood aerobic fitness is associated with deep brain structures and function. Compared to their peers, higher-fit children show greater volumes of globus pallidus and dorsal striatum (components of basal ganglia) as well as better performance on task that measures attention and inhibitory control (Chaddock et al. 2010,), meaning that children that are more fit show enhanced cognitive control. NTC program is based on new neuroscience and pedagogy studies, with the aim of developing creativity and functional knowledge of children. NTC program is characterized by three phases of implementation. Play, as an intrinsic need of a child, represents the key factor of NTC program implementation (Rajović, 2009). Integral part of the first phase, intended for preschool and early-school children are evolutionary accordant activities, characterized by the complex motor activities, including fine motor skills, dynamic eye accommodation, rotation, balance, and movement. The second phase of NTC program is characterized by abstract classifications, abstract seriations, and association, while the goal of the third phase is the development of divergent and convergent thinking, and functional knowledge. Those three phases encompass sensory-motor and cognitive development of children. In order to evaluate the first phase of the NTC Program, we conducted a research with children from 2 to 4 years of age. The Program was implemented for two months. Gross motor skills were assessed prior to the Program implementation as well as after the period of two months.

METHODS

Research was carried out in 2015 and it included two combined groups (2-4 years old) from Kindergartens in Kranj, Slovenia. Experimental (NTC) group from ''Kekec'' unit daily practiced motor activities which are part of the NTC Program. This group has 18 children (9 girls, 9 boys), as well as the control group from unit ''Sonček'' (14 boys, 4 girls). Daily physical activities of the control group consisted of regular, curricular activities. During daily physical activity time, NTC group had also regular curricular activities but in the combination with the NTC program elements (fine motor skills, dynamic eye accommodation, rotation, balance, movement). For the analysis of results, statistical tests for group comparison were used.

RESULTS

Gross motor skills are considerably influenced by the age of a child and because of this it is very important to have comparable groups regarding age. Age related differences were determined using independent-samples t-test.

Table 1: Average age (in months) and standard deviation by groups. T-test results.

Group of children		n	AM	SD	t	df	p
Age	Control	18	41.78	5.17	1.28	28.6	0.210
	NTC	18	38.83	8.24			

* AM = arithmetic mean; SD = standard deviation; n = number of participants; t = statistical test; df = degrees of freedom; p = p - value

As can be seen in Table 1, average age of children in the control group was 42 months, i.e. 3.5 years, whereas in experimental group it was 39 months, i.e. 3.3 years. This difference is not statistically significant (t = 1.28; p = 0.21). With the assistance of Levene's test for equality of variances (F = 5.3; p = 0.028), we concluded that the groups are comparable with each other with regard to their age. Following tables show the results of initial and final testing of both, control and experimental (NTC) group.

Table 2: Initial testing. Number and percentage of children, that successfully completed walking on a line-forward. Likehood-ratio test results.

			Group of children		Total			
			Control	NTC		LR	df	p
walking on a line – forward	Unsuccessful	f	5	6	11	0.131	1	0.717
		f %	27.8 %	33.3 %	30.6 %			
	Successful	f	13	12	25			
		f %	72.2 %	66.7 %	69.4 %			
Total		f	18	18	36			
		f %	100.0 %	100.0 %	100.0 %			

* f = frequency; f % = frequency percentage LR = statistical test; df = degrees of freedom; p = p – value

Initial testing of walking on a line – forward showed comparable results among the groups (LR (1) = 0.13; p = 0.717). Exercise was done successfully by 72.2% in control group and 66.7 % in NTC group.

Table 3: Final testing. Number and percentage of children, that successfully completed walking on a line-forward. Likehood-ratio test results.

			Group of children		Total			
			Control	NTC		LR	df	p
walking on a line – forward	Unsuccessful	F	3	0	3	4.432	1	0.035
		f %	16.7 %	0.0 %	8.3 %			
	Successful	F	15	18	33			
		f %	83.3 %	100.0 %	91.7 %			
Total		F	18	18	36			
		f %	100.0 %	100.0 %	100.0 %			

* f = frequency; f % = frequency percentage; LR = statistical test; df = degrees of freedom; p = p – value

Table 4: Initial testing. Number and percentage of children, that successfully completed walking on a line – backward. Chi-squared test results.

			Group of children		Total			
			Control	NTC		χ^2	df	p
Walking on a line - backwards	Unsuccessful	f	9	17	26	8.86	1	0.003
		f %	50.0 %	94.4 %	72.2 %			
	Successful	f	9	1	10			
		f %	50.0 %	5.6 %	27.8 %			
Total		f	18	18	36			
		f %	100.0 %	100.0 %	100.0 %			

* f = frequency; f % = frequency percentage; χ2= statistical test; df = degrees of freedom; p = p – value

On the final testing, all children from the NTC group successfully completed walking on a line – forward, whereas in the control group this was true for 15 (83.3%) children. Difference was statistically significant (LR (1) = 4.43; p = 0.035).

At the initial testing, all the children in the control group successfully completed walking on a line – backward, as in the NTC group this was the case only for one child. As shown with the initial testing, groups were not comparable (χ2 = 8.9; p = 0.003) prior to the NTC program implementation.

Table 5: Final testing. Number and percentage of children, that successfully completed walking on a line – backward. Chi-squared test results.

			Group of children		Total			
			Control	NTC		χ^2	df	p
Walking on a line - backward	Unsuccessful	f	9	7	16	0.45	1	0.502
		f %	50.0 %	38.9 %	44.4 %			
	Successful	f	9	11	20			
		f %	50.0 %	61.1 %	55.6 %			
Total		f	18	18	36			
		f %	100.0 %	100.0 %	100.0 %			

* f = frequency; f % = frequency percentage; χ2= statistical test; df = degrees of freedom; p = p – value

At the end of conducted research, as shown with final testing, groups were comparable (χ2 = 0.45; p = 0.502). In control group, number of children that successfully completed the exercise did not change. In NTC group, 11 of them (61.1%) have completed the exercise. As shown with two previous tables, no progress was shown in the control group, whereas in NTC group 10 children made a progress (55.6 %). Given difference (LR = 17.81; p < 0.001) is statistically significant.

Table 6: Initial testing. Number and percentage of children, that successfully completed long jump – forward. Chi-squared test results.

			Group of children		Total			
			Control	NTC		χ^2	df	p
Long jump forward	Unsuccessful	f	3	7	10	2.215	1	0.137
		f %	16.7 %	38.9 %	27.8 %			
	Successful	f	15	11	26			
		f %	83.3 %	61.1 %	72.2 %			
Total		f	18	18	36			
		f %	100.0 %	100.0 %	100.0 %			

* f = frequency; f % = frequency percentage; χ2= statistical test; df = degrees of freedom; p = p - value

In regard to the long jump forward exercise, groups are comparable (χ2= 2.22; p = 0.137). In the control group, 15 children (83.3%) successfully completed long lump forward, and in NTC group 11 of them (61.1%). At the end of the research, difference that groups showed for the exercise of long jump forward was not statistically significant (LR (1) = 1.415; p = 0.234). In Table 8, we can see that groups show he difference with regard to completing the exercise of long jump backward (χ2 (1) = 5.9; p = 0.015). In the control group, 10 children (55.6%) successfully completed the exercise, and in the NTC group 3 of them (16.7%).

Table 7: Final testing. Number and percentage of children, that successfully completed long jump – forward. Chi-squared test results.

			Group of children		Total			
			Control	NTC		LR	df	P
Long jump forward	Unsuccessful	f	1	0	1	1.415	1	0.234
		f %	5.6 %	0.0 %	2.8 %			
	Successful	f	17	18	35			
		f %	94.4 %	100.0 %	97.2 %			
Total		f	18	18	36			
		f %	100.0 %	100.0 %	100.0 %			

* f = frequency; f % = frequency percentage; LR = statistical test; df = degrees of freedom; p = p – value

Table 8: Initial testing. Number and percentage of children, that successfully completed long jump backward. Chi-squared test results.

			Group of children		Total			
			Control	NTC		χ^2	df	p
Long jump backward	Unsuccessful	f	8	15	23	5.9	1	0.015
		f %	44.4 %	83.3 %	63.9 %			
	Successful	F	10	3	13			
		f %	55.6 %	16.7 %	36.1 %			
Total		F	18	18	36			
		f %	100.0 %	100.0 %	100.0 %			

* f = frequency; f % = frequency percentage; χ2= statistical test; df = degrees of freedom; p = p – value

Table 9: Final testing. Number and percentage of children, that successfully completed long jump backward. Chi-squared test results.

			Group of children		Total			
			Control	NTC		χ^2	df	p
Long jump backward	Unsuccessful	f	8	2	10	4.98	1	0.026
		f %	44.4 %	11.1 %	27.8 %			
	Successful	f	10	16	26			
		f %	55.6 %	88.9 %	72.2 %			
Total		f	18	18	36			
		f %	100.0 %	100.0 %	100.0 %			

* f = frequency; f % = frequency percentage; χ2= statistical test; df = degrees of freedom; p = p – value

In the control group, number of children that successfully completed this exercise remained unchanged (55.6%), whereas in the experimental group it raised from 16.7% to 88.9%. Groups show statistically significant difference ($\chi2$ (1) = 4.98; p = 0.026) among each other. At the initial testing of squads, successfulness of groups was not comparable (LR (1) = 3.87; p = 0.049). The exercise was successfully completed by 38.9% of children from the control group and 11.1% of children from the NTC group. At the end of the research, all children in NTC group successfully completed squad, whereas in control group 9 children succeeded (50%). Difference is statistically significant (LR (1) = 15.53; p<0.001). At the end of the research, percentage of successfully completed squad is in favor of NTC group, although this was true for the control group at the beginning of research.

Table 10: Initial testing. Number and percentage of children, that successfully completed a squad. Likehood-ratio test results.

			Group of children		Total			
			Control	NTC		LR	df	P
Squad	Unsuccessful	f	11	16	27	3.873	1	0.049
		f %	61.1 %	88.9 %	75.0 %			
	Successful	f	7	2	9			
		f %	38.9 %	11.1 %	25.0 %			
Total		f	18	18	36			
		f %	100.0%	100.0%	100.0%			

* f = frequency; f % = frequency percentage; LR = statistical test; df = degrees of freedom; p = p – value

Table 11: Final testing. Number and percentage of children, that successfully completed a squad. Likehood-ratio test results.

			Group of children		Total			
			Control	NTC		LR	df	P
Squad	Unsuccessful	f	9	0	9	15.535	1	< 0.001
		f %	50.0 %	0.0 %	25.0 %			
	Successful	f	9	18	27			
		f %	50.0 %	100.0 %	75.0 %			
Total		f	18	18	36			
		f %	100.0 %	100.0 %	100.0 %			

* f = frequency; f % = frequency percentage, LR = statistical test; df = degrees of freedom; p = p – value

Table 12: Average number of sucessfully completed excersises and standard deviations by groups and t-test results.

Group of children		n	AM	SD	T	df	P
Age (months)	Control	18	3.00	1.71	2.68	34.0	0.011
	NTC	18	1.61	1.38			

* AM = arithmetic mean; SD = standard deviation; n = number of participants; t = statistical test; df = degrees of freedom; p = p – value

The average number of successfully completed exercises at the beginning of the research in the control group was 3 (SD = 1.7), and in NTC group 1.6 (SD = 1.4). Difference is statistically significant (t (34) = 2.68; p = 0.01) in the favor of control group.

The average number of successfully completed exercises at the end of the research in the control group is 3.3 (SD = 1.6), and in NTC group 4.5 (SD = 0.7). Even though the NTC group exhibited less physical agility prior to the Program implementation, the improvement of this group was greater as measured by final assessment. Additionally, results variability in the NTC group is smaller. Variances among groups are not equal (F = 17.7; p<0.001). T-test of unequal variances shows statistically significant difference among the groups (t(23.6) = 2.87; p = 0.008) in the favor of NTC group.

DISCUSSION AND CONCLUSSION

From five exercises that assessed the gross motor skill abilities (walking on a line – forward, walking on a line – backwards, long jump - forward, long jump - backward, and squats), four showed significant statistical difference in experimental group compared to the control group. Prior to the NTC Program implementation, experimental group exhibited less physical agility. Many children were not able to perform the exercise or were not able to do it properly. However, at the end of the research, this group showed greater improvement than the control group. Experimental group practiced NTC activities 4 times per week, and it was neither time consuming nor special requisites were needed. Therefore, nursery teachers can simply organize specific games during the regular curricular activities which children will not only enjoy, but which will help improve their gross motor skills.

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PHYSICAL EDUCATION OF CHILDREN WITH MEDICAL CONDITIONS

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SUMMARY

The objective of this study is comparative analysis of the possibilities of application physical education for children with health problems and the current status in boys and girls. Understanding the concept of impaired health is a precondition for the realization of the training process and possible integration in the process of physical education, according to the structure of health disadvantages. Comparative analysis will show the positive experiences and obtained results of pilot study in terms of: Institutional providing physical education for health weakened in the family, and Elementary school. Besides the concordance of positive experience will be analyzed results of the questionnaire, which examines the attitudes of students in the integration process of physical education in our country. The questionnaire was designed to assess the physical and psychosocial health of children of both sexes, aged 7 years and over. Quality of life assessment is performed at two levels. The first level is items that are given in the form of a statement. At the second level an item-like particles are observed in the sub-segments (scales) that cover different dimensions of health and quality of life. The raw scores of each scale are transformed into standardized with a possible value of 0-100, which facilitates the interpretation of the results. The Questionnaire Quality of Health and Social Wellness includes 11 segments: 1) S*cale of physical functioning* measure the presence and extent of physical limitations caused by health problems, and includes three important dimensions: self-care, mobility and activities that require more efforts; 2) S*cale implementation of social roles* (depending on physical health) assesses the extent to which physical health interfere with everyday school activities with friends; 3) S*cale of global health* (respondents subjectively evaluate past, present and future health and susceptibility to disease); 4) *Scale of bodily pain* (to measure the intensity and frequency of pain as one of the indicators of physical health); 5) S*cale of emotional impact on the parents* (there is a direct correlation between the estimated health of the child and the degree to which a parent/guardian feels physically and emotionally affected); 6) S*cale implementation of social roles* (depending on the emotional state and behavior); 7) *Self-rating scale* includes three essential components: social security (trust), academic skills and self-esteem; 8) S*cale of mental health* (measure the frequency of positive and negative states; 9) S*cale of behavior* include four dimensions of behavior: aggression, delinquency, hyperactivity/impulsivity, and social rejection; 10) S*cale of family activities and family cohesion* assess the level of constraints for families experiencing child health; 11) S*cale of change in health* register changes in health over the previous year. Analysis of data point out on some minor differences in possibility of physical activity application in children with medical conditions, with special overview of boys and girls from diverse cultural and social backgrounds, in Serbia and region of Niš.

Keywords: physical/health education, schoolchildren, health impairment, questionnaire, self-evaluation

INTRODUCTION

The ***objective*** of this study is comparative analysis of possibilities of physical education for children with health problems and the current status of boys and girls. Health weakness is manifested by attenuation or limitation of physical, sensory, mental function, activity or function of internal organs; they defend the active participation of these individuals in physical education and sport. Understanding the concept of impaired health is a precondition for the realization of activity process and possible integration in the process of physical education.

The ***aim*** of this pilot study is estimation of the attitudes of pupils regarding their health condition, that may has an impact of their possibility of participation in the physical education activities, as well as the sense social well-being.

METHODS

This comparative analysis provide the evaluation of the research results in pupils of upper elementary school of both gender which were collected during the physical education classes in the Elementary school *"St Sava"* in Nis, in December 2014. This pilot study provide the positive experiences in terms of: 1) Institutional security of providing physical education for health weakened in the family, within the social constitution, in special schools, health departments of physical education; 2) Integration of impaired health in physical education; 3) The principles of integration in physical education.

Besides the concordance of positive experience will be analyzed results of the application of the questionnaire, which examines the attitudes of students in the integration process of physical education in our country.

The Questionnaire was designed to assess the physical and psychosocial health of children, of both gender, ageed 7 and older. Quality of life assessment is carried out on two levels. The first level is the level of items that are given in the form of a statement. At another level, item-are seen as particles within the scales that cover various dimensions of health and quality of life. The raw-wert of each scale are transformed into standardized with a possible value of 0-100, which facilitates the interpretation of the results.

Subjects

The sample (Total = 30) was balanced in terms of gender: The study included 15 male and 15 female students, aged from 10-11 to 14-15 years. In the sub-sample of *boys* most of them were from the sixth grade (73.3%), while the others were eighth grade students (26.7%). In the sample of *girls* the situation is similar: the largest number of girls is in the age group up 12 to 13 years, i.e. from the sixth grade (66.7%), while the others belonged to the age group up 14 to 15 years, from the eighth grade (33.3%).

Procedure

This pilot study provid only comparative data, by items within some segments of Questionnaire, with recording only the absolute and relative frequencies of the data collected and the comparative analysis in relation to gender differences. All obtained data were analyzed within some segments (1-11 Scales), and all items included (37 in total).

RESULTS

The introductory part of the Questionnaire (QHSSW) relates to the demographic status of students and their parents, assessed with seven items (ASS1-7). Analysis of data point out on some gender differences in possibility of physical activity application in children with medical conditions, with special overview of the status in boys and girls within families of diverse cultural and social backgrounds in Serbia, region of Niš (see Appendix).

QUESTIONAIRE OF HEALTH AND SOCIAL WELLNES (QHSW)

(A) The Pupils Social Status (ASS1-7)

- (A-01) Gender: (a) Male (15/50%; (b) Female (15/50%);
- (B-02) Child parenting by: Total / Boys / Girls (respectively)

(a) Both parents (83.3% / 80% / 86.7%); (b) Mother (16.7% / 20% / 13.7%); (c) Father (-)

- (C-03) Age of the child: Total / Boys / Girls (respectively)

(a) 6-7; (b) 8-9; (c) 10-11 (6.7% / 13.3% / 0%); (d) 12-13 (66.7% / 60% / 73.3%); (e) 14-15 (26.7% / 26.7% / 26.7%); (f) 16-17;

- (D-04) Age of parents/guardian: Total / Boys / Girls (respectively)

(a) Father (48.2/47.7/49.1); (b) Mother (41/38.4/43.7) (c) Guardian (-)

- (E-05) Grade level of pupils: Total / Boys / Girls (respectively)

(a) I- first, (b) II - second, (c) III – third, (d) IV - fourth, (e) V- fifth, (f) VI-sixth (70%/73.3%/66.7%), (g) VII-seventh, (h) VIII–eighth (30% / 26.7% / 33.3%)

- (F-06-a) Education Level of parent/guardian: (A) Father (B) Mother (C) Guardian

- TOTAL (N=29): (I) Primary school not finished (-); (II) The complete primary school (7.2%); (III) Incomplete secondary school or vocational training (3.6%); (IV) Secondary school diploma (28.6%); (V) College (28.6%); (VI) High school education (32.1%)

- BOYS (n=15): (I) Primary school not finished (-); (II) The complete primary school (13.3%); (III) Incomplete secondary school or vocational training (6.7%); (IV) Secondary school diploma (26.7%); (V) College (30%); (VI) High school education (33.3%)

- GIRLS (n=14): (I) Primary school not finished (-); (II) The complete primary school (-); (III) Incomplete secondary school or vocational training (-); (IV) Secondary school diploma (28.6%); (V) College (35.7%); (VI) High school education (28.6%)

- (F-06-b) Education Level of parent/guardian: (A) Father (B) Mother (C) Guardian

- TOTAL (N=30): (I) Primary school not finished (-); (II) The complete primary school (10.7%); (III) Incomplete secondary school or vocational training (-); (IV) Secondary school diploma (21.4%); (V) College (32.1%); (VI) High school education (35.7%)

- BOYS (n=15): (I) Primary school not finished (-); (II) The complete primary school (13.3%); (III) Incomplete secondary school or vocational training (-); (IV) Secondary school diploma (30%); (V) College (13.3%); (VI) High school education (40%)

- GIRLS (n=15): (I) Primary school not finished (-); (II) The complete primary school (6.7%); (III) Incomplete secondary school or vocational training (-); (IV) Secondary school diploma (20%); (V) College (46.7%); (VI) High school education (46.7%)

- (G-07-a) Occupation of parent/guardian: (A) Father (B) Mother (C) Guardian

- TOTAL (N=28): (I) Unemployed (7.1%); (II) Housewife/Farmer (-); (III) Wage worker/ laborer (3.6%); (IV) Industrial worker/craftsman (-); (V) Civil servant/Entrepreneur (50%); (VI) Manager/Businessman (17.8%); (VII) other/specify profession (21.4%)

- BOYS (n=14): (I) Unemployed (7.1%); (II) Housewife/Farmer (-); (III) Wage worker/ laborer (7.1%); (IV) Industrial worker/craftsman (6.1%); (V) Civil servant/Entrepreneur (50%); (VI) Manager/Businessman (21.4%); (VII) other/specify profession (14.3%)

- GIRLS (n=14): (I) Unemployed (7.1%); (II) Housewife/Farmer (-); (III) Wage worker/ laborer (-); (IV) Industrial worker/craftsman (-); (V) Civil servant/Entrepreneur (50%); (VI) Manager / Businessman (14.3%); (VII) other/specify profession (28.6%)

- (G-07-b) Occupation of parent/guardian: (A) Father (B) Mother (C) Guardian

- TOTAL (N=28): (I) Unemployed (15.4%); (II) Housewife/Farmer (11.5%); (III) Wage worker/ laborer (3.85%); (IV) Industrial worker/craftsman (3.85%); (V) Civil servant/Entrepreneur (38.5%); (VI) Manager/Businessman (3.3%); (VII) other/specify profession (20.7%)

- BOYS (n=14): (I) Unemployed (6.7%); (II) Housewife/Farmer (14.3%); (III) Wage worker/ laborer (-); (IV) Industrial worker/craftsman (6.7%); (V) Civil servant/Entrepreneur (29%); (VI) Manager/Businessman (6.7%); (VII) other/specify profession (21.4%)

- GIRLS (n=14): (I) Unemployed (20%); (II) Housewife/Farmer (6.7%); (III) Wage worker/ laborer (6.7%); (IV) Industrial worker/craftsman (-); (V) Civil servant/Entrepreneur (40%); (VI) Manager/Businessman (-); (VII) other/specify profession (20%)

(B-1) The Scale of physical functioning (BFF8-10)

- (H-8) Is independent students care about them-selves limited due to health conditions?

- TOTAL (N=29): no restrictions (72.3%); partially restricted (24.3%); mostly limited (3.4%); very limited (-)

- BOYS (n=14): no restrictions (64%); partially restricted (29%); mostly limited (7.1%); very limited (-)

- GIRLS (n=15): no restrictions (80%); partially restricted (20%); mostly limited (-); very limited (-)

- (I-9) How many everyday activities are limited because of physical health students?

- TOTAL (N=30): not limited (83%); somewhat limited (6.9%); occasionally limited (10%); very limited (-)

- BOYS (n=15): not limited (80%); somewhat limited (-); occasionally limited (20%); very limited (-)

- GIRLS (n=15): not limited (80%); somewhat limited (13.3%); occasionally limited (6.7%); very limited (-)

- (J-10) How much health students influences the performance of physical activities that require more effort?

- TOTAL (N=29): There are no restrictions (75.8%); partially restricts (6.9%); occasionally restricts (10.3%); completely restrict (6.9%)

- BOYS (n=14): There are no restrictions (78.6%); partially restricts (-); occasionally restricts (14.3%); completely restrict (7.1%)

- GIRLS (n=15): There are no restrictions (73.3%); partially restricts (13.3%); occasionally restricts (6.7%); completely restrict (6.7%)

(C-2) The Scale of Social role implementation (CSSR11-12)

- (K-11) The extent to which physical health interfere with everyday school activities?

- TOTAL (N=28): There are no restrictions (62.1%); partially restricts (13.7%); occasionally restricts (20.7%); completely restrict (3.4%)

- BOYS (n=13): There are no restrictions (69.2%); partially restricts (15.4%); occasionally restricts (15.4%); completely restrict (-)

- GIRLS (n=15): There are no restrictions (60%); partially restricts (13.3%); occasionally restricts (26.7%); - completely restrict (-)

- (L-12) The extent to which physical health of students disrupts daily activities with friends?

- TOTAL (N=27): There are no restrictions (76.9%); partially restricts (3.8%); occasionally restricts (11.5%); completely restrict (7.7%)

- BOYS (n=12): There are no restrictions (76.9%); partially restricts (-); occasionally restricts (15.4%); completely restrict (7.7%)

- GIRLS (n=15): There are no restrictions (66.7%); partially restricts (13.3%); occasionally restricts (6.7%); completely restrict (6.7%)

(D-3) The Scale of the global health (DSGH13-15)

- (M-13) What is a subjective assessment of students' health in the past year?

- TOTAL (N=27) Excellent (55.6%); Good mostly (44.4%); occasionally poor (-); very bad (-)

- BOYS (n=12) Excellent (83.3%); Good mostly (16.7%); occasionally poor (-); very bad (-)

- GIRLS (n=15) Excellent (33.3%); Good mostly (66.7%); occasionally poor (-); very bad (-)

- (N-14) What is a subjective assessment of the current health status of students?

- TOTAL (N=28) excellent (71%); well, with a tendency to improve (21.4%); subject to disease (7.1%); very bad (-)

- BOYS (n=13) excellent (85%); well, with a tendency to improve (7.7%); subject to disease (7.7%); very bad (-)

*- GIRLS (n=15) good (*60%*); well-with a tendency to improve (33.3%); subject to disease (6.7%); very bad (-)*

- (O-15) What is a subjective assessment of the future health of students?

*TOTAL (N=26): Shall be great (*65.4%*); very good (*26.9%*); good, with a tendency to improve (*3.8%*); bad, with deteriorating (*3.8%*)*

*BOYS (n=12): Shall be great (*75%*); very good (16.7%); good, with a tendency to improve (8.3%); bad, with deteriorating (-)*

GIRLS (n=14): Shall be great (57.1%); very good (33.3%); good, with a tendency to improve (-); bad, with deteriorating (6.7%)

(E-4) The Scale of bodily pain (ESBP16-17)

- (P-16) What is a subjective assessment of pain as one of the indicators of health status of students?

*- TOTAL (N=28): No pain (*68%*); anxiety (*7.1%*); some pain (*21.4%*); presence of a very strong pain (*3.6%*)*

*- BOYS (n=13): No pain (*77%*); anxiety (7.7%); some pain (15.3%); presence of a very strong pain (-)*

*- GIRLS (n=15): No pain (*60%*); anxiety (6.7%); some pain (26.7%); presence of a very strong pain (6.7%)*

- (Q-17) What is the frequency of the subjective assessment of pain as one of the indicators of health status of students?

*- TOTAL (N=28): there was no pain (*57%*); occasional discomfort (*30%*); Pain is present almost every day (*13%*); daily, very severe pain (-)*

*- BOYS (N=13): there was no pain (*77%*); occasional discomfort (23%); Pain is present almost every day (-); daily, very severe pain (-)*

*- GIRLS (N=15): there was no pain (*46.7%*); occasional discomfort (40%); Pain is present almost every day (13.3%); daily, very severe pain (-)*

(F-5) The Scale of the emotional impact on the parents (FSPI18-19)

- (R-18) How to assess students limited time for personal needs of parents (guardians) for children's physical and/or psychosocial health *(emotional problems, attention skills, learning agreement with others)?*

*- TOTAL (N=27): Yes, that's limited (*11.1%*); occasionally limited (*14.8%*); partially limited (*7.4%*); Not limited (*66.7%*)*

*- BOYS (n=13): Yes, that's limited (7.7%); occasionally limited (7.7%); partially limited (-); Not limited (*77%*)*

*- GIRLS (n=14): Yes, that's limited (14.3%); occasionally limited (14.3%); partially limited (14.3%); Not limited (*57.1%*)*

- (S-19) How to assess students suffering and worries of parents (guardians) for children's physical and/or psycho-social health *(emotional problems, attention skills, learning agreement with others)?*

*- TOTAL (N=25): No worries (*24%*); mild concern (*52%*); considerable care (*20%*); great emotional anguish and concern (*4%*)*

*- BOYS (n=13): No worries (30.8%); mild concern (*46%*); considerable care (15%); great emotional anguish and concern (7.7%)*

*- GIRLS (n=12): No worries (16.7%); mild concern (*58.3%*); considerable care (23.1%); great emotional anguish and concern (-)*

(G-6) The Scale of Social roles implementation (GSSR20-23)

- (T-20) How are the personal judgment, limited schooling and obligations of students because of my health?

*- TOTAL (N=26): there are no restrictions (*61.5%*); partially restricted (*30.8%*); occasionally restricted (*7.7%*); completely restricted (-)*

*- BOYS (n=13): there are no restrictions (*61.5%*); partially restricted (30%); occasionally restricted (7.7%); completely restricted (-)*

*- GIRLS (n=13): there are no restrictions (*61.5%*); partially restricted (30.8%); occasionally restricted (7.7%); completely restricted (-)*

- U-21) What is the personal judgment, restricted activities with fellow students because of a medical condition?

*- TOTAL (N=27): no restrictions (*66.7%*); somewhat limited (*7.4%*); occasionally limited (*22.2%*); completely restricted (*3.7%*)*

*- BOYS (n=14): no restrictions (*64.3%*); somewhat limited (14.3%); occasionally limited (21.4%); completely restricted (-)*

*- GIRLS (n=13): no restrictions (*69.2%*); somewhat limited (-); occasionally limited (23.1%); completely restricted (7.7%)*

- (V-22) What is the emotional state of students in relation to restrictions on health grounds?

*- TOTAL (N=27): great mood (*55.6%*); good mood (*29.6%*); changing mood (*11.1%*); depression (*3.7%*)*

- BOYS (n=14): great mood (57.1%); good mood (35.7%); changing mood (7.1%); depression (-)

- GIRLS (n=13): great mood (53.8%); good mood (23.1%); changing mood (15.4%); depression (7.7%)

- (W-23) What is the behavior of students in relation to restrictions on health grounds?

*- TOTAL (N=27): active attitude (*64.3%*); benevolent (*17.8%*); occasional outbursts (*10.7%*); hostile (*7.15%*)*

*- BOYS (n=14): active attitude (*71.4%*); benevolent (7.1%); occasional outbursts (21.4%); hostile (-)*

*- GIRLS (n=13): active attitude (*61.5%*); benevolent (30.8%); occasional outbursts (-); hostile (7.7%)*

H-7) The self-rating Scale (HSES24-28)

- (X-24) How satisfied with my student academic achievement?

*- TOTAL (N=27): satisfied (*63%*); mostly satisfied (*30%*); mostly dissatisfied (*3.5%*); very dissatisfied (*3.5%*)*
- BOYS (n=14): satisfied (71.4%); mostly satisfied (21.4%); mostly dissatisfied (7.1%); very dissatisfied (-)
- GIRLS (n=13): satisfied (38.5%); mostly satisfied (53.8%); mostly dissatisfied (7.7%); very dissatisfied (-)

- (Y-25) How satisfied the student's physical abilities?

*- TOTAL (N=27): very satisfied (*46.4%*); mostly satisfied (*46.4%*); mostly dissatisfied (*7.15%*); very dissatisfied (-)*
- BOYS (n=14): very satisfied (57.1%); mostly satisfied (42.9%); mostly dissatisfied (-); very dissatisfied (-)
- GIRLS (n=13): very satisfied; mostly satisfied (); mostly dissatisfied (); very dissatisfied ()

- (Z-26) What is the student satisfied with their appearance?

*- TOTAL (N=27): very satisfied (*62.9%*); mostly satisfied (*22.2%*); mostly dissatisfied (*7.4%*); very dissatisfied (*7.4%*)*
*- BOYS (n=14): very satisfied (*85.7%*); mostly satisfied (14.3%); mostly dissatisfied (-); very dissatisfied (-)*
*- GIRLS (n=13): very satisfied (*38.5%*); mostly satisfied (30.8%); mostly dissatisfied (15.4%); very dissatisfied (15.4%)*

- (AA-27) What is the personal assessment of students in relation to the ability of agreement with their friends and family members?

*- TOTAL (N=27): satisfied (*59%*); mostly satisfied (*33%*); mostly dissatisfied (*8%*); very dissatisfied (-)*
*- BOYS (n=14): satisfied (*57%*); mostly satisfied (35.8%); mostly dissatisfied (7.1%); very dissatisfied (-)*
*- GIRLS (n=13): satisfied (*61.5%*); mostly satisfied (31%); mostly dissatisfied (8.5%) very dissatisfied(-)*

- (AB-28) How satisfied overall student life?

*- TOTAL (N=27): satisfied (*74%*); mostly satisfied (*14.8%*); mostly dissatisfied (*7.5%*); very dissatisfied (*3.7%*)*
*- BOYS (n=14): satisfied (*78.6%*); mostly satisfied (21.4%); mostly dissatisfied (-); very dissatisfied (-)*
- GIRLS (n=13): satisfied (69%); mostly satisfied (8%); mostly dissatisfied (15%); very dissatisfied (8%)

(I-8) Mental health Scale of (IMHS29-30)

- (AC-29) How often a student is worried because of their mental health condition?

*- TOTAL (N=28): never (*67.8%*); sometimes (*28.6%*); almost always (-); all the time (*3.6%*)*
*- BOYS (n=13): never (*61.5%*); sometimes (30.7%); almost always (-); all the time (7.7%)*
*- GIRLS (n=15): never (*73.3%*); sometimes (26.7%); almost always (-); all the time (-)*

- (AD-30) How often a student is happy with his physical and medical condition?

*- TOTAL (N=28): never (*13%*); sometimes (*17.8%*); almost always (*25%*); all the time (*44.2%*)*
*- BOYS (n=13): never 15.4%); sometimes (15.4%); almost always (15.4%); all the time (*53.8%)
*- GIRLS (n=15): never (13.3%); sometimes (20%); almost always (*33.3%*); all the time (*33.3%*)*

(J-9) The Scale of Behavior (JBHS31-33)

- (AE-31) How often do students exhibit aggressive behavior?

*- TOTAL (N=27): never (*44.4%*) sometimes (*44.4%*) often (*11.2%*); always (-)*
- BOYS (n=12): never (58.3%); sometimes (33.3%); very often (8.3%); always (-)
- GIRLS (n=15): never (33.3%); sometimes (53.3%); very often (13.3%); always (-)

- (AF-32) How often student sanctioned for delinquent behavior?

*- TOTAL (N=28): never (*70.4%*); sometimes (*25.9%*); often (-); always (*3.7%*)*
- BOYS (n=13): never (76.9%); sometimes (23.1%); often (-); always (-)
- GIRLS (n=15): never (60%); sometimes (26.7%); often (-); always (6.7%)

- (AG-33) How often do students exhibit hyperactivity/impulsivity?

*- TOTAL (N=28): never (*38.5%*) sometimes (*26.9%*) often (*34.6%*) always (-)*
- BOYS (n=13): never (38.5%); sometimes (23%); often (38.5%); always (-)
- GIRLS (n=15): never (33.3%); sometimes (26.7%); often (26.7%); always (-)

(K-10) The Sale of Family activities and Family cohesion (KSFR34-36)

- (AH-34) How the student's environment globally is estimated children's behavior?

*- TOTAL (N=28): Excellent (*53.6%*); very good (*28.6%*); Good (*10.7%*); poor (*7.1%*)*
*- BOYS (n=13): Excellent (*46.1%*); very good (38.5%); Good (15.4%); poor (-)*
*- GIRLS (n=15): Excellent (*60%*); very good (20%); Good (6.7%); poor (13.3%)*

- (AI-35) How the child's health disrupted normal family activities or cause family tension?

*- TOTAL (N=28): never (*75.0%*); sometimes (*17.8%*); often (*3.6%*); always (*3.6%*)*
*- BOYS (n=13): never (*85%*); sometimes (15%); often (-); always (-)*
*- GIRLS (n=15): never (*66.7%*); sometimes (20%); often (6.7%); always (6.7%)*

- (AJ-36) How well the student's family members disagree among themselves?

*- TOTAL (N=28): Excellent (*71.5%*); very good (*17.8%*); Good (*7.1%*); poor (*3.6%)
- BOYS (n=13): Excellent (69.2%) very good (23.1%); Good (-); poor (7.7%)
- GIRLS (n=15): Excellent (73.3%); very good (13.3%); Good (13.3%); poor (-)

(L-11) The scale of change in health (LSHC37)

- (AK-37) How the student assesses changes in health over the last year?

- *TOTAL (N-28): much better now (*53.5%*), tendency of improvement (*39.3%*), tendency of deterioration (*3.6%*), much worse now (*3.6%*)*

- *BOYS (n-13): much better now (*76.9%*); tendency of improvement (23.1%); tendency of deterioration (-); much worse now (-)*
- *GIRLS (n-15): much better now (33.3%); tendency of improvement (*53.3%*); tendency of deterioration (6.7%); much worse now (6.7%)*

CONCLUSION

This pilot study was carried out with aim to assess the possibility of physical education application in children with health problems and to compare the current status in elementary school boys and girls. For this purpose was applied the ***Questionnaire of Health and Social Wellness* – QHSW** (according to Kvrgić, S., 2001) on the balanced sample of elementary school students divided in two sub-samples (15 boys and 15 girls). Analysis of data point out on some gender differences in possibility of physical activity application in children with medical conditions, with special overview of the status in boys and girls within families of diverse cultural and social backgrounds in Serbia, and region of Niš.

In the introductory part of the Questionnaire are presented some demographic parameters of respondents (elementary school children and their family members) regarding age of children and parents (mother and father), parental care for children, educational level of both parents and their occupation. The Questionnaire applied consists of 11 segments and 37 items within them with the possibility of the respondents to choose answers on the Likert-type scale.

Scale of physical functioning measure the presence and extent of physical limitations caused by health problems, and includes three important dimensions: self-care, mobility and activities that require more efforts. On the base of total sample analysis and comparative analysis of results provided by boys and girls there were not estimated significant differences between boys and girls. The majority of statements were related to answers such are no constraints, not limited or no restrictions. There are no significant differences between boy and girls.

Scale of Social role implementation *(depending on physical health),* before mainly judged on the basis of absences from school, until now considered being of great importance as for the ability to socialize and agreement with others. Accordingly, this scale assesses the extent to which physical health interfere with everyday school activities with their friends. No significant differences between boys and girls were estimated, when is about an ability to socialize and agreement with others. Majority of children evaluate this segment as with no limitations.

Scale of the global health - In this part of the questionnaire respondents subjectively evaluate past, present and to future health and susceptibility to disease. A low score means that the children's health assessed as "poor", with a worsening trend, whereas a high score comes to evaluating health as excellent and the belief that it will remain so. The most frequent answers were excellent and mostly good, with prevalence of these statements in Boys-sample."

Scale of the bodily pain includes items foreseen to measure intensity and frequency of pain as one of the indicators of physical health. The pain or discomfort is assessed through responses ranging from "no pain" to "present a very strong pain" (with a time limit on the last 4 weeks). Majority of respondents in Boys/Girls sample have declared for the option "no pain" or "occasional discomfort", and there were noted some differences, while in the girls sample were noted some statements that "pain" is present almost every day (13%).

Scale of the emotional impact on the parents. Research shows that there is a direct correlation between the estimated health of the child and the degree to which parents feel physically and emotionally affected. To measure the impact of child health on parents were constructed two scales: Scale of weathering, and Scale of emotional impact. Majority of respondents pleaded as "not limited", but there were some differences between Boys (77%) and Girls-samples (57%).

Scale of the social roles implementation (depending on the emotional state and behavior). Low score means that the children, because of their behavior or emotional problems, are substantially limited in performing school or other daily activities with friends, while a high score means that there is no limitation. Majority of boys and girls pleaded for the option "no limitation", or "partially limited". There were no significant differences between Boys/ Girls-samples.

Self-rating Scale*.* Self-assessment is a multidimensional phenomenon that occurs during the pre-adolescent and shape and redefine during their lifetime, and includes three essential components: social security (confidence), academic skills and self-esteem. Scale that is used in this survey includes the following dimensions: satisfaction of the school and physical abilities, satisfaction with appearance, as well the ability of agreement with others and with family members, and overall satisfaction with life. The statements of boys and girls are slightly different, while girls are declare within some segments as occasionally and completely limited, or changeable mood, and depression.

Scale of Mental health measure the frequency of positive and negative states. Low score of mental health talk about feelings of anxiety and depression that are present all the time, whereas a high score means that the child is at all times calm and happy.

Scale of behavior. Frequency of problems related to behavior rated on a scale that has been designed to include four dimensions of behavior: aggression, delinquency, hyperactivity / impulsivity, and social rejection.

Scale of family activities and family cohesion. Family situation is of great importance for children's health, while the health condition of a child can affect family relationships. This questionnaire assess the *level of restrictions* that families experience because of their children's health and *the relationship* in the family, where the respondents answer how well the members their family agree among themselves, with majority responses ranging as "excellent" in all samples.

Scale of change in health register changes over the previous year. Answers range from "much better now" as were in Boys-sample (76.9%), then “tendency of improvement” in Girls-sample (53.3%); followed with “tendency of deterioration” (6.7%); to "much worse now," (6.7%) in Girls-sample, so that a low score tells on the deterioration, and a high score on improving health.

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Physical Activity and Health

DIFFERENT ASPECTS THAT MAY INFLUENCE ON BONE MINERAL DENSITY IN BALLET DANCERS

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SUMMARY

Although artists, ballet dancers have strenuous exercises and long hours of practice, still their slim figure maintain with negative energy intake. Such lifestyle leads to various eating disorders, increased prevalence of amenorrhea and risk of early osteoporosis. Delayed menarche, amennorhea and low body mass index seems to be the best indicators for osteopenia. As one of the most important topics right now, osteoporosis in dancers had been investigating, but the results are different. The multifactorial nature of bone mineral density include high genetic influences, but also other environmental, body composition, hormone level, exercise, and diet being the most important ones. Study has shown that the bone mineral density is lower in dancers comparing to other athletes, but not comparing with non-exercising control group. Treatment with oral contraceptives did not have positive effect on bone mineral density, so the best prevention should include a non- pharmacological combination strategies such as- nutrition consultation, minimum weight requirements and/or specifications for weight gain, psychological counseling, exercise/physical activity limitations, and/or additional rehabilitative, biomechanical, and muscle strengthening exercise.

Key words: ballet dancers, prevalence, bone mineral density, osteoporosis risks

INTRODUCTION

Osteoporosis has become one of the most important topics to women in general as well as in female athletes. Studies have shown that high-impact weight-bearing activity is beneficial for the load-bearing sites of the skeleton. However, bone health depends of many factors, such as the type of activity, intensity and duration of the physical activity, age of starting the activity, etc. Sports which are classified as endurance or demands lean body, carries with it certain risks. Although classical ballet belongs to the art, it is actually very physically challenging. Ballet dancers are engaged in weight-bearing and strenuous exercises, but their slim figure they maintain with negative energy intake. The consequences of such lifestyle lead to eating disorders (ED), increased prevalence of amenorrhea and risk of early osteoporosis. Many teenage dancers demonstrate high energy expenditure, extreme leanness, and delayed puberty. They all influence on bone health. It is probable that the restriction of energy intake over the long-term is responsible for growth and health impairment (Yannakoulia et al., 2004). Ballet dancers consistently weight 10-12% below ideal weight and diet to maintain this low weight. Body mass acquired during adolescence and early adulthood may be one of the most important determinants for the risk of osteoporosis later in life. According to study by Stokic et al. (2005), 50% of ballet dancers were underweight, and 43.8% reported delayed menarche. The multifactorial nature of bone mineral density (BMD) include high genetic influences, other are environmental, body composition, hormone level, exercise, and diet being the most important ones. The risk factors for BMD assessed at baseline included low body weight (< 85% and < 95% of ideal body weight), low body mass index (BMI < 17.5 kg/m^2 and < 18.5 kg/m^2), high volume exercise (defined as >12 h/wk of purposeful exercise), elevated dietary restrain, pathogenic weight behavior, participation in a leanness sport, late age of menarche, oligomenorrhea/amenorrhea, and low BMD (Z score < -1.0 and < -2.0). Studies in ballet show conflicting results, ranging from low BMD to relatively high BMD. BMI alone is not a determinant of BMD, but muscle mass has an independent effect.

Nutritional aspects

Eating disorders are widespread among elite but also in non-elite ballet dancers. Examples of ED include fasting or chronic restrained eating, skipping meals, binge eating, self induced vomiting, restrictive dieting, unbalanced eating, laxative and diuretic use. This leads to very serious diseases such as anorexia nervosa (AN), bulimia nervosa (BN) and eating disorders not otherwise specified (EDNOS). Seventy percent of dancers in the study (Frusztajer et al. 1990) consumed less than 85% of Recommended Dietary Allowances. The rhythmic gymnasts and ballet dancers had a deficient energy and calcium intake for the physical exercise they performed. Subjects with deficient energy intake run the risk of stunted growth, delayed puberty, menstrual irregularities, decreased physical output, increased numbers of lesions, and increased possibilities of suffering from eating disorders. (Sundgot-Borgen, 1996). Study by Quintas et al. (2003) shown that comparing women from skiers, basketball players and dancers, that the worst bone density status have dancers, who, as a group, displayed characteristics that have negative impacts in this respect -low energy intakes and low body weight and insufficient energy intake were associated with poorer bone mineralization status. The trochanter fraction was lower in dancers than values in other two groups of athletes. Low energy intake is known to be associated with decrease in resting metabolic rate (RMR). Depressed metabolic rate is associated with lower BMD and leptin levels in women ever having had amenorrhea. It is possible that depressed metabolic state, low bone density and low leptin levels may all be manifestation of the same underlying cause- poor nutrition and long-term restricted energy intake, resulting from the high propensity of ballet dancers to diet (Kaufman et al., 2002). Restriction of nutritional intake has also been associated with stress fractures in ballet dancers and may affecting bone quality as well. This may explain the tendency of dancers to fracture, even when menstrual function is reported to be normal.

Aspects of Pubertal Development

Growth during puberty depends on nutritional status, hormonal regulation, genetic and environmental factors. Dancing represents a beneficial activity for children for optimizing peak bone mass. Study **by** Matthews el al. (2006) which lasted 3 years demonstrate a positive effects of dance training on the skeleton in prepubertal girls (11-14 years) as well as the maintenance of an already existing bone mineral advantage. Also, a positive impact of ballet training on bone density in weight-bearing sites as the hips has been shown in young girls around the age of menarche of 10 to 12 (Khan et al., 1998). However, because most of these girls had started basic dance around the age of menarche it appears logical to speculate that at least part of their bone gain is from earlier years before they entered formal dance training. Bone mass acquired during adolescence and early adulthood may be one of the most important determinants for the risk of osteoporosis later in life. Elite female rhythmic gymnasts and ballet dancers exhibit a specific pattern of growth characterized by a marked delay in skeletal maturation and pubertal development (Bass et al., 2000). A prolonged prepubertal state, because of a significant delay in menarche, a strong positive correlation between age at menarche, years of ballet before menarche, as well as age at which dance was begun, and total years of ballet are also observed in dancers. This factors deeply affects preadolescence and adolescence, critical periods in which the peak bone mass accumulaton of lumbar spine is obtained (Theintz et al., 1992). Many studies have shown that malnutrition in young ballerinas also leads to delayed menstruation. A positive correlation between BMD and year of first menarche confirmed the importance of exposure to estrogens and the negative impact of delayed puberty (Burckhardt et al., 2011). In professional female dancers, delay of menarche and duration of secondary amenorrhea has a significant negative relationship with BMD at the lumbar spine as well as that delayed menarche in girls also seem to prevent the normal peak bone accretion (Keay et al., 1997). Possible explanations are bone mineralization may be stimulated earlier in women with early menstruation due to an estrogen surge after initiation of menses, or delayed menarche is indicative of inadequate hormone levers during adolescence. Among environmental factors that can alter growth and sexual maturation are low body fat, stress, and intense physical training. The age at which dance training starts also appear to be crucial in determining the impact of the training on bone mineral accrual. The intensity of training of young dancers is less demanding so luckily they rapidly return menses during their summer vacation or in less active months in between major performances.

Aspects of menstrual disorders

Menstrual alteration was reported to be particularly high in sports characterized by leanness, suggesting that low energy availability and/or low body fat may play a major role in this phenomenon. Factors that may affect menstrual disorder (MD) are genetic aspect, psychosocial stressors, neuro-endocrine and metabolic factors. The prevalence of MD in elite ballet dancers was reported in range of 66-79%, where 51% professional dancers and 34% of non-professional dancers had MD which was very high for amateurs. (Bacchi et al., 2013). A significant low body weight, with reduction in BMI was evident in dancers, leading to a significant reduction in some nutritional parameters and subsequently in BMD. Menstrual function is lost when body fat decreases to less then 22% of body weight (Frish & Mc Arthur., 1974). Athletic amenorrhea is strongly related to disorder eating and caloric restriction and exogenous estrogens may be ineffective at improving BMD in the absence of improved nutrition and weight gain. The results show that women with hypothalamic amenorrhea have lower BMD that remains below normal menstruating counterparts over two years. (Warren et al.,1991). While exercise during a critical adolescent period has been shown to modulate the negative effect on bone accretion associated with hypoestrogenic amenorrhea, exercise does not sufficiently protect the amenorrheic athlete from bone loss,(Khan et al., 1999). The expected increase in bone density of mechanically stressed bone does not occur in amenorrheic dancers and significantly, none of the women who resumed menses did not achieved normalization of BMD. Weight gain may not be the proximal causal factor in resumption of menses, but rather a manifestation of improved energy availability. Remarkably, BMD declines as the number of missed cycle accumulates (Dirnkwater et al., 1990) and the loss of BMD may not be fully reversible. The lack of normalization suggest that reduced bone accretion might result in a permanent failure to achieve peak bone mass, which underscores the importance of intervention, either preventive or therapeutic (**8**, from schools and companies). Often a weight gain of 1-2 kg or a 10% decrease in exercise load is sufficient to reverse reproductive dysfunction (Drinkwater et al., 1986), and the mean BMI within the healthy range of 18.5-25 kg/m2 is another factor that further contributes to the normal BMD values reported. **(5).** Menstrual history is the best predictor of current BMD and that a history of amenorrhea is associated with lower BMD. Any decrease in BMD at the femoral neck in dancers with history of amenorrhea is partially attenuated by virtue of it being the major weight bearing site in dance training, and in eumenorrhoeic dancers BMD at this site is significantly increased. (Keay et al., 1997).

Aspects of Physical Activity

Girls start to engage ballet from 2 to 14 years. Training hours depends on the level of schools, companies, types of dance which varies from 20 to 48h per week. The effect of exercise depends on estrogen levels and type of physical activity-specifically, the intensity, duration, and frequency of exercise performed. Women with exercise-induced hypothalamic amenorrhea frequently present with osteopenia, which may result from reduced bone accretion or premature bone loss (Jonnavithula et al., 1993). Exercise-induced amenorrhea may be due to a metabolic imbalance caused by a caloric intake that is insufficient for the level of activity and the osteopenia may be another adaptive response to cronic low energy intake reflected in a low turnover state. Dancing may provide an ideal osteogenic stimulus, particularly at hip region, because the various jumps and landings that typify dancing impart unusual and high-impact loads on skeleton. Loading is essentially restricted to the trunk and lower extremities and may therefore exert an osteoprotective effect at these sites (Karlsson et al., 1993).

Eumenorheic vs. Ammenorheic dancers

Beside eating disorders, ballet dancers have a high rate of menstrual dysfunction. The incidence of oligo/amenorrhea disorder range from 20% to 65% (Kaufman et al., 2002; To et al., 2005), depending on study, and the type of dancer (Classical ballet, modern dance etc.). Classical ballet dancers are at the greatest risk, since they have the lowest BMI. It is noteworthly that over a 54.8% of the dancers reported using birth control, and it is possible that menstrual irregularities in the present dancers would be even higher without its use. However, dancers with normal weight also suffer from hypothalamic amenorrhea. It is considered that amenorrhea occurred when three consecutive cycles are missed, while athletes with oligomenorrhea reported having 4 to 9 menstrual cycles or a reported menstrual cycle length > 36 days in the past year. Long term amenorrhea in athletes leads to osteopenia. The complication of osteopenia is much more prevalent in ballet dancers and other amenorrheic athletes than in the normal population. In athletes, it has been shown that eumenorrheic athletes have better than average BMD, while amenorrheic athletes have lower vertebral BMD (9-31% lower) than eumenorrheic ones (Loyd et al. 1988). Study by To et al., (2005) show that young women undergoing regular intensive weight-bearing exercises as in the collegiate dancers have higher BMD in the axial and appendicular skeleton as compared to non-exercising females of the same age if they remain eumenorrhoeic during their training. The lumbar spine BMD and hip BMD trochanter were significantly higher in the eumenorrhoeic dancers as compared to controls. When adjusted for growth and maturation, dancers had significantly greater BMC at the total body (TB), lower limbs, femoral neck (FN) lumbar spine (LS) than control. This advantage was apparently lost when they developed oligo/amenorrhoea. Results by Warren et al. 2003 show that elite amenorrheic patients were deficient in BMD compared to eumenorrheic dancers ballet dancers. Those with menstrual dysfunction did not differ from those that remained eumenorrheic in their basic anthropometric parameters, nor was the serial change in these parameters in the second assessment different between the two groups. Study by Keay et al., (1997) show that the amenorrhoeic dancers had significantly reduced BMD at the lumbar spine compared with eumenorrheic dancers and control group, but BMD at the femoral neck was not significantly reduced. This suggests that the FN rather than the lumar spine is the site that benefits most from the weight bearing nature of dance training.

Dancers vs. control group

Although numerous studies have shown reduced bone density in ballet dancers, comparing to non-exercising control group, ballet dancers still show better results. The modern dancers exhibited significantly greater BMD at the spine and hips than controls. (Friensen et al., 2011). Even though, dancers in this study had a healthy body weight, it is reported a higher incidence of ED and menstrual disfunction than non-dancers. In prepubertial dance girls, results were significantly greater in BMC at the TB, lower limbs, femoral neck (FN), and lumbar spine (LS) than controls. At the FN, dancers had 4% greater BMC than controls in prepuberty and maintained this advantage throughout the pubertal years (Matthews et al., 2006). Van-Marken-Lichtbelt et al., (1995) reported that mean BMD of ballet dancers is significantly higher (6%) than the reference population. These high values could be attributed to the high BMD of legs and pelvis, the weight-bearing sites of the dancer's body. Whereas study by Karlsson et al., (1993) reported no significant difference in BMD values between dancers and controls, but that professional female ballet dancers had greater lower-limb BMD than controls when results adjusted for differences in BMI. Tsai et al. revealed no significant difference of BMD of the lumbar vertebrae and the femoral neck between dancing group and control. The dancing group had significant higher BW- and BMI-corrected BMD of the lumbar vertebrae compared to the control group, although dancers were significantly thinner. (Tsai et al., 2001).

Stress fracture

A stress fracture is recognized complication of ballet dancing. Professional dance companies have reported that 67% to 95% of their dancers are injured on an annual basis. Dancers with delayed menarche showed the most stress fractures. Those with a lower BMI may also have less muscle mass, which may relate to the risk of bone stress injury. Results from (Barrack et al., 2014) show that when evaluating variables as single, those exhibiting the strongest associations with a bone stress injury included participating in purposeful exercise for >12 h/wk, low BMD (Z score < -1.0 at the lumbar spine and/or total body) and BMI below the median value for the sample (<21.0kg/m^2). Single factors that significantly predicted low BMD included late age of menarche, low body weight, low BMI, oligo/amenorrhea, and current participation in leanness sport or activity. Dancers with fractures showed a significantly greater tendency to restrict food intake, manifested by a greater percentage eating less than 85% of the recommended dietary allowance, lower fat intake, higher intake of low-caloric foods and sugar substitutes, and greater incidence of ED. (Frusztajer et al., 1990). Previous studies in dancers have shown that amenorrhea is one of the most important factor. The only variable found to correlate with the occurrence of stress fractures was age of menarche (Calabrese et al., 1983; Warren et al., 1991).effect on BMD and that age of menarche was the only variable that significantly predicted stress fractures (Warren et al., 1986).

Treatment and prevention

Physicians have conventionally treated amenorrheic athletes with hormone therapy or oral contraceptives (OC), but these treatments are controversial. Research has no yet consistently demonstrated the efficacy of hormone therapy or oral contraceptives in increasing the bone mass of women with hypothalamic amenorrhea. Over the 2 years, there were no differences in BMD between the amenorrheic dancers who received estrogen-progestin therapy and those who did not. Also, there was no difference in the slopes of the regression lines for bone density over 2 years. Baseline, bone mineral density was lower at all three sites and remained lower in the spine in amenorrheic in spite of treatment (Arendts et al., 2012). However, the results indicated that a weight gain or BMI increase may be important predictors of menses restoration. Athletes with weight gain of 2.27 or more were twice as likely to resume menses as those with less weight gain. So a non-pharmacological intervention in female athletes and ballet dancers with menstrual disorders can restore regular menstrual cycles, although restoration of menses may take more than 1 year (Lagowska et al., 2014). After a 9 months of therapy there were less subjects with secondary amenorrhea. Changes in body weight after that period was 1.3 kg. Resumption of a regular cycle that would more likely represent hypothalamic recovery, and not simply the existence of the menstrual bleed. The reversibility of the osteopenia is uncertain because of the lack of longitudinal studies, and effectiveness of different therapies also remains unproven. The resumed menstrual cyclicity is associated with increased bone mass in athletes, but despite a return of cyclicity, normalization of bone mass has not occurred in cases of athletic amenorrhea. The American College of Sport Medicine recommends treating menstrual dysfunction in athletes primarily by increasing the caloric intake and reducing the energy expenditure. (Nattiv et al., 2007). However, this recommendation is not easily accepted by dancers. It is therefore crucial to restore menses of amenorrheic athletes as soon as possible as to minimize bone loss and bone complications resulting from osteopenia and osteoporosis. Further research is necessary to determine the most effective treatment strategy for nutritionally linked bone remodeling imbalance.

DISCUSION

Conclusion data suggest that a low energy intake, combined with intense physical exercise in puberty, could be associated with negative effect on the reproductive and skeletal systems in ballet dancers. Dancers engage in weight-bearing, strenuous exercise, have increase prevalence of amenorrhea and low levels of body fat associated with ED, smoke cigarettes, consume alcohol, and ingest caffeine via coffee and other caffeine-based beverages that elevate fracture-risk, low body mass index (BMI) for age, low energy intake, and delayed puberty. On the contrary, being a healthy eumenorrheic dancer have a positive influence on bone mineral density, and that should be the main goal of all dancers and their coaches. The increased awareness of the endocrine-metabolic consequences on BMD in the dance world is crucial to preventing these risks. Dance teacher and dancers themselves need greater awareness and correct information on the potential risks of low body weight, menstrual problems and poor dietary habits on skeletal health and the prevention of osteoporosis in later life. Continued monitoring of this novel population, including a comparison of those who continue dancing with those who discontinue dancing, would further determine whether benefits of exercise are maintained into adulthood with a reduction of the exercise stimulus. Treatment and prevention should include a combination of strategies such as nutrition intervention, minimum weight requirements and/or specifications for weight gain, psychological counseling, exercise/physical activity limitations, and/or additional rehabilitative, biomechanical, and muscle strengthening exercise. Further longitudinal studies in these active young women with menstrual dysfunction would provide data as to their bone density status in later life.

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CHARACTERISTICS OF EATING DISORDERS IN FEMALE AESTHETIC ATHLETES

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UDC 613.2-055.2

SUMMARY

Eating disorders (ED), menstrual dysfunction (MD), and osteoporosis are the three interrelated components of the female athlete triad, a potentially serious syndrome often seen in physically active girls and women, which can result in decreased performance, both short and long term morbidity, and even mortality. The long hours of daily physical training, the pressure to maintain an extremely thin body to achieve aesthetic and performance ideals, as well as the need to be technically, artistically and aesthetically excellent are similar demands in both ballet and gymnastics. The pressure to be thin and food restriction as a way to attain the ideal body are important ED risk factors. A great prevalence of ED was recorded both at ballet dancers and gymnasts where the main impact is competitive atmosphere, negative comments of coaches and unrealistic weight goals. Recovery process is long, and it should include psychological reprogramming such as building healthy self-esteem, reducing self-criticism, a support by people around them.

Keywords: characteristics, eating disorders, ballet dancers, gymnastics

INTRODUCTION

Aesthetic sports include dancing, acrobatics, artistic swimming etc. Participating in aesthetic sport report more anorexic indices than participating in either ball games or endurance sports. Eating disorders (ED) , menstrual dysfunction (MD), and osteoporosis are the three interrelated components of the female athlete triad, a potentially serious syndrome often seen in physically active girls and women, which can result in decreased performance, both short and long term morbidity, and even mortality (Yeager et al., 1993). (Francisco et al., 2012). Eating disorders is defined as abnormal eating habits associated with a permanent worry about weight and body image, have been considered a public heath thread, mainly affecting female. High expectations and pressure from parents, coaches, and teammates are among main factors causing ED. (Dosil & Gonzalez, 2008). The judge criteria which stress thinness are another essential factor in the etiology of ED in some sports (Thompson & Sherman, 1993). Dancers can also be considered as special athletes. The long hours of daily physical training, the pressure to maintain an extremely thin body to achieve aesthetic and performance ideals, as well as the need to be technically, artistically and aesthetically excellent are similar in both ballet and gymnastics (Davis & Strachan, 2001; Koutedekis & Jamurtas, 2004). The higher the body weight, the poorer the athletic performance will be in most cases. Although weight can limit an athlete significantly, it is actual percentage of body fat that tends to be the determining factor (meaning that a leaner athlete will typically perform better in competition). (Francisco & Narciso, 2012). Female dancers and gymnasts are also the most frequent targets of critical comments and rigid rules related to low weight and thin body image. The majority of research in this area has integrated dance and gymnastics into the group of aesthetic or leanness sports because of their similar demands in terms of extreme pressure to be thin and long hours of physical training, although ballet has a fundamentally artistic component, while gymnastics has a strong athletic component in addition to the artistic one.

Characteristics of eating disorders

The world of classical dance or elite gymnastics is considered a specific area, where the values and beauty ideals shared by an industrialized culture roughly have the same influence among adolescents, As the result, the life of an adolescent athlete often involves a combination of intense physical training combined with pressure to meet unrealistic weight goals as a means of improving performance. The pressure to be thin and food restriction as a way to attain the ideal body are important ED risk factors that are shared by dancers and gymnasts alike. Teachers and coaches are clearly essential sources of influence on young dancers and gymnasts, especially regarding their body and eating attitudes and behaviors. For gymnasts, the coaches are seen as the principal source of influence, who often make negative comments about eating, monitoring athletes weight, and advice on food restriction. Rosen and Houhh, (1988) reported that 75% of female gymnasts who were told by coaches that they were too heavy used pathogenic weight control methods. Other studies report high pressure from gymnasts coaches in the context of high level competitions and professional dance schools and link such pressure to an increased risk for the development of ED (Kerr et al. 2006; Toro et al., 2009).

Because some characteristics of the classical dance and elite gymnastics world cannot be easily changed, factors such as social support or positive relationships between athletes and tutors could be vital to prevent development of ED. In artistic gymnastics, the ideal body shape is to be small, thin, and light but strong, whereas the ideal body for rhythmic gymnasts is to be taller and very thin, so it certainly seems possible that these athletes could be under even more pressure to be thin than other gymnasts. (Sundgot-Borgen, 1994). Dieting at an early age appeared to be associated with the onset of ED and some of the risk factors are pressure for thinness, emotional distress, and negative comments about eating, weight, body image. For ballet dancers, thinness is experienced as an implicit rule of the world of classical dance. A study of female ballet dancers (Ringham et al, 2006) revealed that 83% of them reported some form of eating pathology, including AN 6,9%, BN 10.3% and EDNOS 55%. In study (Nascimento et al., 2012) ballet dancers displayed a lifetime history of AN -15.78%, a rate that is more than 17-time higher than reported in the general female population. Similar prevalence rates of AN -12% were reported in Norwegian elite athletes of aesthetic sports (including diving, figure skating, gymnastics, rhythmical gymnastics, and sport dance). Result show it appears that nearly one fifth of ballet dance student suffer from ED, predominantly from EDNOS type (eating disorders not other specified). When comparing to non-dancers group, ballet students had twice the chance of developing EDNOS. Also, a very serious condition is anorexia nervosa, which is very common among aesthetics athlete caused by ED. It is a subtype of anorexia, a form of EDNOS with a favorable prognosis commonly affecting athletes and attributable more to environmental pressures to be thin and the constant scrutiny to which athletes and dancers are subjected than to deep-rooted pathology. Anorexia athletica can be seen as a state of reduced energy intake and reduced body mass despite high physical performance.

Characteristics associated with ED and sport participation are: competitiveness, concern about performance, compulsive concern about body shape, drive for thinness and perfectionism. Also, girls with low self-esteem at early adolescence seem to have greater risk of developing and ED in the following years. Performing a sport whose atmosphere is highly competitive, may put them under unbearable pressure (Bettle et al.,2001). Rhythmic gymnastics as a competitive sport require speed, power, gracefulness, and aesthetic appeal, both physical shape and strength are necessary (D'Alessandro et al., 2007). Leanness is particularly valued because a gymnast's success is a function of either technical performance or appearance. Aesthetic performers perceive pressure to remain thin in their environment, they are more likely to engage in unhealthy eating behaviors, especially if they also present low self-esteem and are dissatisfied with their body image. Likewise, the classical dance environment is extremely competitive, especially in national schools. The dance school as source of influence is high because the students are staying from 3-4 hours to 10-12 hours a day, respectively, while gymnasts reported training on average of 23-24 hours a week (Klentrou et al., 2003). Ballet students attending national schools presented ED behaviors than exceeded those of regional and local students. Professional dancers reported BMI, current and ideal weight lower than those reported by amateur dancers (Pollatou et al., 2010) and still study show that despite having a BMI that is lower than that of control group, female ballet dancers and students in professional ballet schools report in general a desire to achieve an even lower weight, below 82% of normal body weight (Bettle et al., 1998), Female gymnasts, elite or non-elite, also seem to want to lose more weight than females in control group, even though they showed a significantly lower BMI (de Bruin et al., 2007). Regarding ballet dancers, (Toro et al., 2009) study showed that BMI above 18 in female ballet students was significantly associated with intense dissatisfaction with weight for artistic reason but not for personal reasons.

Various individual characteristics are associated with ED, such as perfectionism, low self-esteem and body dissatisfaction. The results of several authors are showing that the drive for thinness is strictly related to the performance and plays a relevant role in influencing the perception of body shape. Association between perfectionism and ED has been consistently found (Penniment et al., 2011; Thomas et al., 2005). A large amount of literature establishes body image dissatisfaction and low-self-esteem as strong predictors of ED in athletes and general population. Results are showing that elite athletes were significantly more dissatisfied with their body image than the non-elite athletes, they showed greater concern with thinness than non-elite athletes and control, and they also scored higher on social pressure compared with non-elite athletes, but they didn't score higher than the controls. Elite female dancers are significantly more dissatisfied with their body image than non-elite female dancers. Body image disturbance was quite common in dancers and in body builders, independently of BMI and the presence of ED diagnosis.

Perfectionism among dancers has been repeatedly associated with greater levels of eating psychopathology (Penniment et al., 2012; Thomas et al., 2005) and suggested elements include high standards and self-criticism (Goodwin et al., 2014). The results show that high standards and self-criticism are positively associated with eating restrain, eating concern, weight and shape concern, with self-criticism demonstrating relatively stringer association with the measured aspects of eating psychopathology than did high standards. Higher levels of perfectionism have been found in female adolescent dancers compared to non-dancers (Anshel, 2004), but other studies have not found these differences. In the study by Nordin et al., (2003), rhythmic gymnast aged 10-15 years, scored significantly higher on the Drive for Thinness subscale of the EDI than did either artistic gymnasts or sports acrobats. Accordingly to this study, perfectionism was positively correlated with total eating disturbance and Drive for Thinness scored, however rhythmic gymnasts did not display higher levels of perfectionism than did other gymnasts. The results do not indicate psychopathological similarities between the elite rhythmic gymnasts and the AN patients, even though some physical aspects resemble. All together no parallels in psychopathology were found between elite rhythmic gymnasts and AN patients. This might indicate that athletes are more stable and well-balanced. A positive outlook on life, and high self-efficacy have been identified as protective factors and may characterize athletes and dancers. Participation in sports can positively influences mental health outcomes.

DISCUSION

A greater prevalence of ED are among specific sports with high levels of competition, specifically in aesthetic sports, which emphasize thinness and associated improvements in performance, such as dance, gymnastics, figure skating. Numerous individual, familial, and socio-cultural risk and protective factors have been identified in ED. It is also important that coaches and teachers learn about the effect of their comments on athlete self-esteem and body image. The loss of a coach, injury, or illness might be conceptualized as traumatic events that serve as trigger conditions for the onset ED. Recovery process is long, and it should include psychological reprogramming such as building healthy self-esteem, reducing self-criticism, a support by people around them. The role of parents in supporting their athletics children should be further explored, especially among gymnasts, who revealed poor involvement of their parents in gymnastics issues. Specially designed preventive programs are needed to reduce level of ED. Further research should focus on a wide range of gymnastics clubs and dance schools, both in elite/competitive and recreational environments and needed to examine whether aesthetic athletes who develop EDNOS possibly anorexia athletica, are particularly prone to environmental pressures, whether they objectively experience more pressure to lose weight than others, whether they differ genetically from other athletes etc.

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UNIVERSITY STUDENTS' ATTITUDES TOWARDS THE IMPORTANCE OF BEING PHYSICALLY ACTIVE

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SUMMARY

Due to the fact that preschool, as well as Physical Education teachers are the key factors of motivating the students and promoting physical activity, the aim of this paper is to determine the attitudes and the disagreements between attitudes of 83 Upper Vocational School students, Major: Kindergarten and Preschool Education, and 150 Faculty of Sport and Physical Education students. The sample of respondents was composed of first, second, and third year students. The sample of measuring instruments was a 20-question questionnaire. T-test for independent samples showed there was a statistically significant difference between the FSPE Niš and UVS Subotica students' opinions regarding 10 questions, while the other 10 questions didn't show any statistically important disagreement between these two groups.

Keywords: physical activity, sport, university students, preschool teachers

INTRODUCTION

Physical activity in children is starting to draw the world science community's attention more and more, considering the noticeable trend of its decrease among all ages. Preschool teachers' attitudes towards organizing games in preschool institutions represent a very important indication of their professional activities, pedagogic qualifications and attitudes towards work. In preschool ages, games possess multiple functions; they most importantly have influence on motivating the children toward achieving the goals set by their teacher during the activity; they help improve the children's relation towards future preschool and, later, school activities (Bjelica, & Krivokapić, 2010). Physical education should enable the students to achieve an important deal of recommended daily amount of physical activity, but also the knowledge about its importance in life (Scruggs and sar., 2003). The teacher is the key factor of motivating the student and promoting a physical activity in general, so, therefore, the students who are satisfied with the PE class are far more physically active outside the school (Vilhjamsson and Thorlindsson, 1998). This research was the one with the aim of questioning the attitudes of student preschool teachers and Faculty of Sport and Physical Education students, about the importance of having a physical activity, and in that manner theoretically determine their competence and knowledge provided to them by previous education, which they should continue to transfer onto others during their future pedagogical work.

METHODS

The sample of respondents was assembled out of 90 Upper Vocational School students, Major: Kindergarten and Preschool Education, 86 of which were female and 4 of which were male, together with 120 Faculty of Sport and Physical Education students from Niš (94 of which were of male and 26 of female sex). The sample of respondents belonged to the first, second or third year of university.

The sample of measuring instruments was made from 20 questions. The first part of the questionnaire was related to the basic information, such as: grade, sex, and previous education. The second part contained questions which had the goal of evaluating the attitudes of student preschool teachers and the Faculty of Sport and Physical Education students towards the importance of being physically active and being involved in a sport. The questionnaire was anonymous and the respondents were not constricted by time limit for reading and answering all of the questions.

Data analysis was done by the SPSS statistics 20 program. T-test was used for independent samples and difference determination.

RESULTS

Table 1 – The Difference between FSPE Niš and UVS Sub Students' Attitudes

Question Num.	University	N	Mean	Std. Deviation	T	Sig. (2-tailed)	Eta Squared
Question 2	FSPE Niš	120	4,5583	,5152	5,891	,000	,156
	UVS Sub	93	3,9785	,8337			
Question 3	FSPE Niš	120	4,7833	,4335	10,781	,000	,355
	UVS Sub	93	3,9677	,6667			
Question 4	FSPE Niš	120	4,2417	,6216	,344	,719	,001
	UVS Sub	93	4,2043	,8915			
Question 5	FSPE Niš	120	4,3167	,8980	7,699	,000	,229
	UVS Sub	93	3,2258	1,1144			
Question 6	FSPE Niš	120	4,4583	,8877	4,795	,000	,098
	UVS Sub	93	3,8280	1,0281			
Question 7	FSPE Niš	120	4,5083	,8696	6,935	,000	,186
	UVS Sub	93	3,6452	,9399			
Question 8	FSPE Niš	120	3,7167	1,4153	,173	,863	,000
	UVS Sub	93	3,6882	,9888			
Question 9	FSPE Niš	120	4,4583	,6847	3,118	,002	,044
	UVS Sub	93	4,1183	,9070			
Question 10	FSPE Niš	120	4,7167	,4882	4,542	,000	,095
	UVS Sub	93	4,3548	,6366			
Question 11	FSPE Niš	120	4,5500	,6963	5,045	,000	,109
	UVS Sub	93	4,0430	,7505			
Question 12	FSPE Niš	120	3,8250	1,1998	,373	,710	,001
	UVS Sub	93	3,7742	,7819			
Question 13	FSPE Niš	120	3,0333	1,1222	-2,823	,005	,036
	UVS Sub	93	3,4946	1,2564			
Question 14	FSPE Niš	120	1,5083	,5020	-7,462	,000	,188
	UVS Sub	93	1,9140	,2819			
Question 15	FSPE Niš	120	3,1250	1,1991	-,195	,846	,000
	UVS Sub	93	3,1613	1,4543			
Question 16	FSPE Niš	120	2,8000	1,1782	-,824	,411	,003
	UVS Sub	93	2,9355	1,2051			
Question 17	FSPE Niš	120	3,0833	1,1120	,051	,959	,000
	UVS Sub	93	3,0753	1,1817			
Question 18	FSPE Niš	120	3,4250	1,2613	,212	,832	,000
	UVS Sub	93	3,3871	1,3354			
Question 19	FSPE Niš	120	4,5417	,5328	-1,116	,265	,006
	UVS Sub	93	4,6237	,5298			
Question 20	FSPE Niš	120	3,8750	1,4175	1,803	,073	,015
	UVS Sub	93	3,5269	1,3720			

T-test for independent samples showed there was a statistically significant difference between the FSPE Niš and UVS Subotica students' opinions regarding 10 questions, while the other 10 questions didn't show any statistically important disagreement between these two groups.

By observing table 1 we can see that Question 2, which is: "*student sports activities contribute to better social bonding in young people*," has a statistically significant difference between the FSFV Niš students' and UVS Subotica students' attitudes (t=5,891; p=,000). According to the mean value we can see that the FSFV Niš students (Mean=4,56) agree with this statement more than the UVS Subotica students do (Mean=3,98) (Graph 1). According to the eta squared values (Eta Squared=0,156) we can see there is a **great** difference between the groups. According to Kohem 0,01 is a small influence, 0,06 medium, 0,14 or more – great influence (Pallant, 2011).

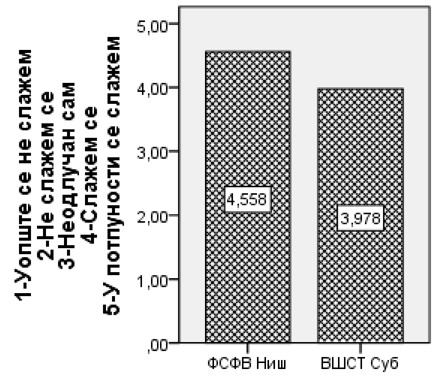

График бр.1

With further analysis, together with the observation of table 1, it can be seen that regarding question 3, which states: "*I am well-informed about the importance of having a physical activity for a proper psycho-physical development*," in which the university students did self-evaluation of their awareness of this issue, there is a statistically significant disagreement between the FSPE Niš students and UVS Subotica students (t=10,781; p=,000). According to the mean value we can see that the FSPE Niš students (Mean=4,783) did a greater job of self-evaluating their awareness of the importance of having a physical activity for proper development, unlike the UVS Subotica students (Mean=3,9677) (Graph 2). According to the eta squared value (Eta Squared=0,355) we can conclude that there is a **great** difference between the groups.

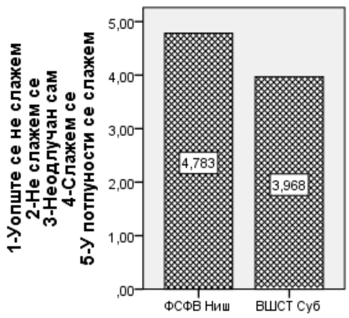

График бр.2

Statistically significant divergence between the UVS Subotica and FSPE Niš students can also be seen with question 5, which states: "*I spend enough time being physically active*" (t=7,699; p=,000). According to the mean value we can see that the FSPE Niš students (Mean=4,317) agree with this statement more than the UVS Subotica students (Mean=3,226) (Graph 3). According to the eta squared value here (Eta Squared=0,098) we conclude there is a **great** difference between these two groups.

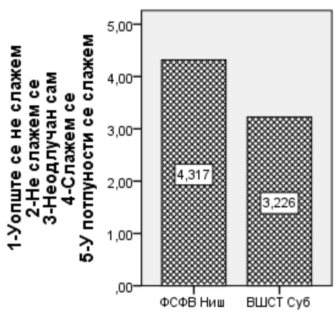

График бр.3

Statistically great difference between the UVS Subotica and FSPE Niš students can also be seen with question 6, which says: "*I find it important to include mandatory PE classes in other universities*" (t=4,795;

p=,000). According to the mean value it is apparent that the FSPE Niš students (Mean=4,458) agree mo re with this statement of incorporating obligatory PE courses in other universities, than the students of UVS Subotica (Mean=3,828) (Graph 4). According to the eta squared value (Eta Squared=0,229) it can be concluded that the difference between the groups is, again, **great**.

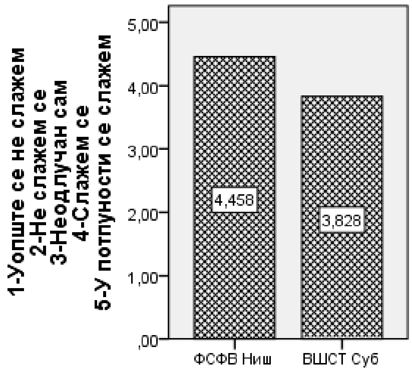

График бр.4

Statistically great difference between the UVS Subotica and FSPE Niš students can also be seen with question 7: "*I feel that PE teachers should also teach the first, second, third, and fourth grade of primary school*" (t=6,935; p=,000). According to the mean value we can see that the FSPE Niš students (Mean=4,508) agree more with the thought of PE teachers teaching from the first to fourth grade, rather than the UVS Subotica students (Mean=3,645) who agree with this statement less (Graph 5). According to the eta squared value (Eta Squared=0,186) we find that the difference between groups is, once again, **great**.

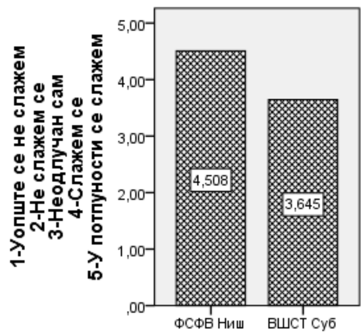

График бр.5

Statistically great difference between the UVS Subotica and FSPE Niš students can also be seen with question 9, which states: "*staying healthy is my main motive for having physical activities*" (t=3,118; p=0,002). According to the mean value we see that the FSPE Niš students (Mean=4,458) agree more with this statement of their main motive being staying healthy, than the UVS Subotica students (Mean=4,118) do (Graph 6). The eta squared value (Eta Squared=0,044) shows the difference between the groups being **small** in this case.

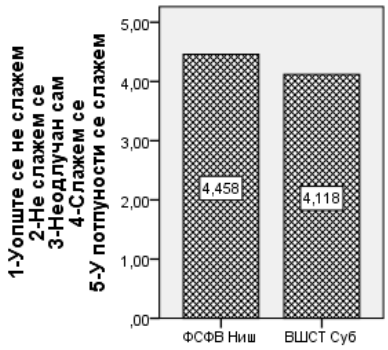

График бр.6

Statistically great difference between the UVS Subotica and FSPE Niš students can also be seen with question 10, which states: "*after having done some physical activity, I feel more satisfied*" (t=4,542; p=0,000). The mean value here shows the FSPE Niš students (Mean=4,717) agree more with this statement of feeling more satisfied, than the the UVS Subotica students (Mean=4,355) (Graph 7). According to the eta squared value (Eta Squared=0,095) the difference between the groups here is **medium**.

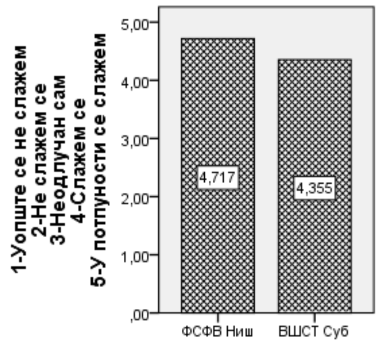

График бр.7

Statistically great difference between the UVS Subotica and FSPE Niš students can also be seen with question 11, which states: "*after doing some physical activity I feel less stressed*" (t=5,045; p=0,000). Here, again, the mean value shows that the FSPE Niš students (Mean=4,550) agree more with feeling less stressed after a physical activity, than the UVS Subotica students do (Mean=4,043) (Graph 8). According to the eta squared value (Eta Squared=0,109) we find the difference between groups being **medium**.

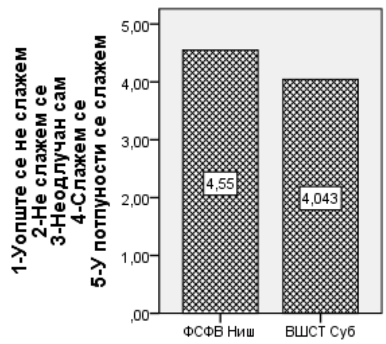

График бр. 8

Statistically great difference between the UVS Subotica and FSPE Niš students can also be seen with question 13: "*Physical activities can cause some negative effects*" (t=-2,82; p=0,005). According to the mean value we can see that the UVS Subotica students (Mean=3,495) agree more with this statement; that doing physical activities can have negative side-effects; than the FSPE Niš students (Mean=3,033) (Graph 9). According to the eta squared value (Eta Squared=0,036) we can conclude that the difference between attitudes of these two groups is **small**.

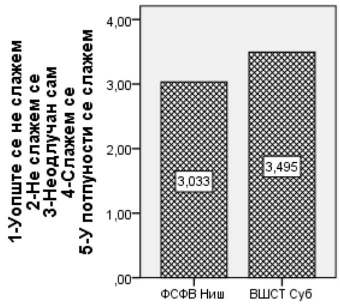

График бр.9

Statistically great difference between the UVS Subotica and FSPE Niš students can also be seen with question 14, which is: "*Are you currently an active participant of a sports club*" (t=-7,462; p=0,005). From the mean value we can see that the UVS Subotica students (Mean=1,9140) are less involved in being active in sports clubs, than the FSPE Niš students (Mean=1,508) (Graph 10 and graph 11). According to the eta squared value (Eta Squared=0,188) the difference between the two groups is **great**.

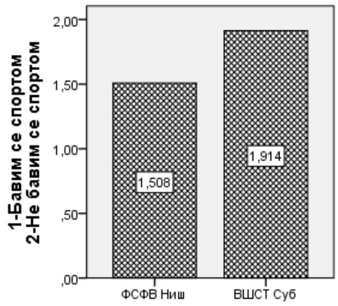

График бр.10

DISCUSSION

The results show there is a statistically important disagreement between the Faculty of Sport and Physical Education Niš students' attitudes and the Upper Vocational School Subotica, Major: Kindergarten and Preschool Education, students' attitudes towards being physically active in 10 of the questions, while the other ten held no significant difference between the attitudes of these two groups.

The results were highly expected due to the fact that the differences between groups mostly went in favor of FSPE students. In other words, the FSPE students agreed more than UVS students with these questions: "*student sports activities contribute to better social bonding in young people*;" "*I am well-informed about the importance of having a physical activity for a proper psycho-physical development*;" "*I spend enough time being physically active;*" "*I find it important to include mandatory PE classes in other universities;*" "*I feel that PE teachers should also teach the first, second, third, and fourth grade of primary school;*" "*staying healthy is my main motive for having physical activities;*" "*after doing some physical activity I feel less stressed.*" The responses which hold a significant difference between groups, and which go in favor of the UVS students, are related to this question: "*Physical activities can cause some negative effects.*" The FSPE students gave a larger amount of positive responses regarding being involved in a sport, than the UVS students did.

The results show that the FSPE students are more informed about the importance of being physically active and its positive effects on regular growth and development, as well as improving the quality of life in general. Such results were more or less expected due to the fact the FSPE curriculum covers a larger number of subjects which are related to this problem, unlike the UVS curriculum which does not deal with this problem as much.

There were no differences between groups in responses to these questions: "*Regular and proper physical activity is of great importance for a proper development*;" "*Better looks are my main motive for being physically active;*" "*I have regular physical check-ups;*" "*Are you satisfied with the offered sports* *choices in your city;" "I think that sport is way overstressed nowadays;" "The Media helps the education about the importance of physical activities for a proper psycho-physical development in young people;" "Income per household;" "Doing sports contributes to the proper psycho-physical development in young people;" "Doing sports becomes a disturbing factor during the examination terms."*

The FSPE students are more in agreement with the claims that PE courses should be incorporated in other universities, as well as the fact that PE teachers should be teaching from the first to fourth grade of primary school.

CONCLUSION

With this research's results taken into account we find that the Faculty of Sport and Physical Education students in Niš are statistically far more informed about the importance of being physically active, than the Upper Vocational School students in Subotica, as well as all their attitudes being far more positive when it comes to being physically active. Furthermore, the FSPE students believe that the first, second, third and fourth grade PE class in primary school should be thought by a professional and trained party, or in other words, physical education and sports teacher, as well as it being desirable to include physical education courses in other universities, which is different from the UVS students' opinions. It can be concluded that these kinds of attitudes stem from the Upper Vocational School students' lack of education and awareness. The importance of the given results that the FSPE students are more informed about the importance of being physically active is satisfying, due to the fact that they will, after having finished their studies, become physical education and sports teachers and their attitudes will greatly affect the way the PE course in their future schools will be like. Likewise, the preschool teacher's attitudes, which have been reached due to this research, are a significant indicator of their future professional activity, pedagogical competence and attitude towards work. Undoubtedly will their attitudes, respectively, reflect on the type and content of activities which will be daily-present in the preschool curriculum.

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MOTOR ABILITIES OF EIGHT-YEAR-OLD GIRLS OF DIFFERENT NUTRITIONAL STATUS

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SUMMARY

Nutritional status of children is one of the most important indicators of health, mental and physical capabilities and potential for normal and healthy growth and development. Excessive body mass in overweight and obese children is associated with stagnation in motor development and creation of motor habits. The aim of this study was to determine differences in specific motor abilities of eight-year-old girls of different nutritional status. The research was conducted on a sample of 91 second grade students of elementary schools in Nish, aged 8.03 (± 0.25) years. After measuring body height and weight and calculating BMI according to Cole et al. (2000), three sub-samples (normal weight, overweight and obese) were formed. Motor abilities (explosive strength, coordination and speed) were determined by a battery of nine tests. Differences in motor abilities between the groups were determined by using MANOVA / ANOVA and LSD Post Hoc test. The results show that differences between the groups are statistically significant in explosive strength, coordination and speed. It is noted that normal weight subjects are significantly better than overweight and obese subjects in explosive leg strength, coordination and running speed. Obese subjects have significantly better results in explosive arm strength than normal and overweight subjects. It can be concluded that overweight and obese subjects have major difficulties in the realization of motor tasks with greater overall movement, which involves lifting and projecting body through space.

Keywords: explosive strength, coordination, speed, nutritional status, female students

INTRODUCTION

Increase in the number of obese people is registered in children, adolescents and adults worldwide. Lack of physical activity and caloric nutrition are some of the dominant factors for the development of obesity in the last 20 years (Burke, 2006; Lobstein, Baur, & Uauy, 2004; Lustig, 2006; Roberts, Lucas, & Hirsch, 2000). Combined effects of these changes have a negative impact on the overall health of children and adults, which is why the WHO has designated obesity as one of the most important public health problems (WHO, 2000). The occurrence of obesity during childhood and adolescence increases the possibility of obesity in adulthood. It was found that obesity in girls and boys in 30% and 10% of cases, respectively, occurs later in adulthood (Goran, 2001).

Nutritional status of children is one of the most important indicators of health, mental and physical capabilities and the potential for normal and healthy growth and development. Nutritional status is often shown by the values of body mass index (BMI - Body Mass Index), which is in children, unlike adults, interpreted in a different way. BMI in children and adolescents is caused by chronological age, stage of pubertal development, gender and ethnic origin (Rosner, Prineas, Loggie, & Daniels, 1998).

Nutritional status and motor abilities in children of different ages were brought in relation which pointed to their negative correlation (Ara, Moreno, Leiva, Gutin, & Casajús, 2007; Biskanaki et al., 2004; D'Hondt et al., 2009; D'Hondt et al., 2013; Kostić et al., 2010; Pantelić, Kostić, Đurašković, Uzunović, & Ranđelović, 2012; Tokmakidis, Kasambalis, & Christodoulos, 2006). Children with increased body weight and subcutaneous fat tissue achieve lower results in motor tasks that require lifting and projecting body through space (Casajús, Leiva, Villarroya, Legaz, & Moreno, 2007; Leskošek, Strel, & Kovač, 2007; Malina et al., 1995). Research suggests that high values of body mass index are in negative correlation with cardiorespiratory fitness and level of physical activity in girls (Mota, Santos, Guerra, Riberio, & Duarte, 2002; Mota, Flores, Flores, Riberio, & Santos, 2006).

Excessive body mass in overweight and obese children leads to stagnation in motor development and creation of motor habits (Bala, 2007; Cawley & Spiess, 2008; Graf et al., 2004a, 2004б; Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006). Lower level of motor abilities in overweight and obese children is associated with muscle dysfunction, as a consequence of physical inactivity, which has its indirect effect on emergence of a number of physical deformities (De Sá Pinto, De Barros Holanda, Radu, Villares, & Lima, 2006; Jannini, Doria-Filho, Damiani, & Silva, 2011; O'Melley, Hussey, & Roche, 2012).

The aim of this study was to determine whether there is a difference in explosive strength, coordination and speed in eight-year-old girls of different nutritional status.

METHODS

Subjects

The research was conducted on a sample of 91 second grade students of elementary schools "Ratko Vukicevic," "Car Konstantin" and "Sveti Sava" in Nish, aged 8.03 (± 0.25) years. All the subjects were healthy on the testing day and had written consents from their parents and the school principal. Measuring and testing took place in school facilities during the physical education class. Anthropometric measurements were implemented by the method recommended by the International Biological Program (Weiner & Lourie, 1969). After measuring body height and weight and calculating BMI according to Cole, Bellizzi, Flegal, & Dietz (2000), three sub-samples were formed. The first sub-sample consisted of 53 normal weight subjects with an average BMI of 16:00 (± 1.69) and average age of 8.07 (± 0.40). The second sub-sample consisted of 29 overweight subjects with an average BMI of 19.40 (± 0.66) and average age of 8.06 (± 0.02). The third sub-sample consisted of nine obese subjects with an average BMI of 24.37 (± 1.62) and average age of 7.96 (± 0.32).

Procedure

Motor abilities were determined by using the battery of nine tests for evaluation of explosive strength, speed and coordination. The testing protocol was described in the study by Kostić et al. (2010).

- For evaluating explosive strength the following tests were used: Plyometric jump, Hyperextension, twist, and throw and Standing depth jump.
- For evaluating coordination the following test were used: Horizontal jump rope, 20 sidesteps with a baton and Running and rolling.
- For evaluating of speed the following test were used: Hand tapping, Foot tapping against a wall and 5×10 meter run.

Statistical analysis

The parameters of central tendency and dispersion for all the variables were calculated. Differences between the groups were evaluated by using multivariate and univariate analysis of variance. In the case of significance between the groups, the LSD Post Hoc test was used. The results were analyzed with the Statistical Package for the Social Science (SPSS), version 12.0.

RESULTS

The parameters of central tendency and dispersion in the applied variables are shown in Table 1. By analyzing Table 1 we can note that the most of the results are well-grouped and have a normal distribution around the means, except in plyometric jump and horizontal jump rope in all three groups, as well as in 20 sidesteps with a baton in the group of obese subjects. Values of skewness indicate that almost all variables are within the normal distribution, especially in the group of overweight subjects. Values of kurtosis substantially differ from normal distribution in almost all motor tests, which indicates lengthiness in the results, thus the samples in all three groups are not homogeneous.

Table 1. Basic descriptive parameters for motor abilities in all three sub-samples

	Normal body weight (n=53)				Overweight (n=29)				Obese (n=9)			
	Mean	SD	Skew	Kurt	Mean	SD	Skew	Kurt	Mean	SD	Skew	Kurt
Body height	133.12	6.80	0.40	0.22	133.93	5.57	0.17	-1.09	141.19	4.87	-0.82	-0.61
Body weight	28.50	4.60	-0.16	-0.89	34.87	3.38	0.12	-0.89	48.67	5.10	0.29	-0.39
BMI	16.00	1.69	-0.48	-0.34	19.40	0.66	0.70	0.05	24.37	1.62	0.69	-0.21
Plyometric jump	14.57	5.64	-0.05	-0.48	14.69	5.23	0.43	-0.51	10.44	3.91	-0.72	0.16
Hyperextension, twist, and throw	48.77	15.08	0.13	-0.51	46.37	14.29	0.21	-0.45	59.71	14.01	-0.20	-1.15
Standing depth jump	108.44	31.54	-2.19	5.85	96.93	29.91	-0.84	1.38	108.11	11.04	0.98	0.50
Horizontal jump rope	4.91	3.72	0.88	1.41	4.28	2.95	0.55	0.29	4.00	2.92	-0.31	-1.65
20 sidesteps with a baton	24.17	6.86	0.98	1.62	23.78	7.07	0.27	-0.89	26.50	9.47	1.20	1.26
Running and rolling	20.36	2.54	0.19	-0.06	22.17	4.45	0.68	0.30	21.84	2.59	-0.01	-0.04
Hand tapping	28.42	5.45	0.28	-0.51	27.07	6.08	-0.46	-0.69	29.89	3.18	0.34	-1.43
Foot tapping against a wall	14.51	2.22	0.17	0.65	13.62	2.29	-0.05	-0.44	14.78	2.05	-0.40	0.44
5×10 meter run	18.37	1.73	0.38	-0.47	19.85	2.63	0.36	-0.94	19.14	2.22	1.30	2.31

Legend: Mean – average value; SD – standard deviation; Skew - skewness; Kurt – kurtosis; n – number

Results of multivariate and univariate analysis of variance are shown in Table 2. Results of multivariate analysis of variance indicate that differences in motor abilities between the groups are statistically significant ($p < .05$). The one-way analysis of variance showed that there were statistically significant differences in 5×10 meter run and running and rolling ($p < .05$). In other motor tests, significant differences between the groups were not detected.

Table 2. Multivariate and univariate analysis of variance in motor abilities between the groups of different nutritional status

	F	Sig.
Plyometric jump	2.44	.093
Hyperextension, twist, and throw	2.85	.063
Standing depth jump	1.47	.236
Horizontal jump rope	0.48	.621
20 sidesteps with a baton	0.50	.606
Running and rolling	3.13	.049*
Hand tapping	1.07	.347
Foot tapping against a wall	1.77	.176
5×10 meter run	4.69	.012*
Wilk's = 0.670 F = 1.97 p = .014*		

Legend: Wilk's - Wilk's lambda test; F - test; p (Sig.) – level of significance; * significant at the .05 level

Table 3 shows the results of LSD Post Hoc test in motor abilities by comparing groups of normal weight, overweight and obese subjects.

Analysis of results (Table 3) shows that explosive leg strength in plyometric jump test was statistically significantly higher in normal weight and overweight subjects than in obese subjects. Significant differences between the groups weren't recorded in the standing depth jump, although normal weight subjects had higher results than overweight and obese subjects. Differences in explosive arm strength indicate that obese subjects are statistically significantly better than normal weight and overweight subjects.

In coordination, statistically significant difference was recorded only between normal and overweight subjects in the running and rolling test, where normal weight subjects were significantly better. In the horizontal jump rope test normal weight subjects had the best results, while obese subjects had the worst. In the 20 sidesteps with a baton test overweight subjects had the best results, followed by normal weight, while obese subjects had the worst results.

Table 3. LSD Post Hoc test in motor abilities

	GROUPS		Mean Diff.	Sig.
Plyometric jump	Normal	Overweight	-0.12	.921
	Normal	Obese	4.12	.036*
	Overweight	Obese	4.25	.041*
Hyperextension, twist, and throw	Normal	Overweight	2.41	.481
	Normal	Obese	-10.94	.042*
	Overweight	Obese	-13.35	.020*
Standing depth jump	Normal	Overweight	11.51	.097
	Normal	Obese	0.33	.976
	Overweight	Obese	-11.18	.327
Horizontal jump rope	Normal	Overweight	0.63	.428
	Normal	Obese	0.91	.465
	Overweight	Obese	0.28	.833
20 sidesteps with a baton	Normal	Overweight	0.40	.811
	Normal	Obese	-2.32	.373
	Overweight	Obese	-2.72	.325
Running and rolling	Normal	Overweight	-1.81	.019*
	Normal	Obese	-1.49	.211
	Overweight	Obese	0.32	.798
Hand tapping	Normal	Overweight	1.35	.292
	Normal	Obese	-1.47	.459
	Overweight	Obese	-2.82	.182
Foot tapping against a wall	Normal	Overweight	0.89	.087
	Normal	Obese	-0.27	.739
	Overweight	Obese	-1.16	.176
5×10 meter run	Normal	Overweight	-1.48	.003**
	Normal	Obese	-0.76	.317
	Overweight	Obese	0.72	.375

Legend: Sig. - level of significance; Mean Diff. – mean difference; * significant at the .05 level ; ** significant at the .01 level

Regarding speed, when it comes to frequent movement speed of arms and legs, there were no significant differences between the groups. It is observed that the results are approximately equal in groups, with obese subjects having the highest and overweight subjects having the lowest results. In running speed normal weight subjects achieved higher results compared to overweight and obese, but statistical significance was recorded only between normal and overweight subjects.

DISCUSSION

Results of this study suggest that normal weight subjects outperform overweight and obese subjects in explosive leg strength, coordination and running speed. Study by Suchomel (2005) states that children with low motor efficiency have significantly higher values of body weight, BMI and subcutaneous fat tissue compared to those with high level of motor abilities.

Our results indicate that normal weight subjects have significantly higher results than the overweight in 5×10 meter run and in running and rolling. In fact, the movement structures in these motor tasks are very similar and involve lifting and projecting the body through space, with frequent changes of direction in short periods of time. As it was expected, excessive body mass negatively affected the realization of mentioned tasks. Our results are directly or indirectly compatible with the results of other studies (Brunet, Chaput, & Tremblay, 2007; Biskanaki et al., 2004; Gontarev & Ruzdija, 2014; Siahkouhian, Mahmoodi, & Salehi, 2011; Yusof, Aiman, Zawi, Hasan, & Radzi, 2013).

The determined differences confirmed that normal weight and overweight subjects achieved significantly higher results compared to the obese in plyometric jump. Those results are consistent with previous research, which indicates that increased body mass has a negative impact on the manifestation of power in jumping (Đokić & Međedović, 2013; Milanese, Bortolami, Bertucco, Verlato, & Zancanaro, 2010; Riddiford-Harland, Steele, & Baur, 2006; Runhaar et al., 2010). Comparing to the plyometric jump, in standing depth jump there were no significant differences between the groups, although group of normal weight subjects had the highest results. Such results can be partially explained by the fact that the motor behaviour of children at this age is still complex and undefined, and that the performance of standing depth jump is technically demanding for children, compared to the plyometric jump. According to Bala (1999) children, unlike adults, do not yet have a defined mechanism for regulation of excitation intensity, because it is located within the mechanism for movement structuring. In this regard, in children when performing the standing depth jump the harmony of movement in arms and legs is severely compromised, as well as maximum mobility of motor units. In explosive arm strength obese subjects were significantly better than normal and overweight subjects, as confirmed by other researchers (Podstawski & Boryslawki, 2012; Riddiford-Harland et al., 2006). In our study obese subjects had higher height and body weight than normal and overweight subjects which, from biomechanics standpoint, facilitated performance by increasing the generation of greater force and output speed during the throwing itself. Rodić (2002) in a study, conducted on a sample of seven-year-old girls, found a significant positive correlation between body height and body mass with explosive arm strength.

In the tests for evaluating coordination of arms and legs, although there were no significant differences between the groups, obese subjects recorded lower results than normal and overweight subjects. Previous studies suggest conflicting results when it comes to linking nutritional status with coordination in children. Reasons for this are different methods of testing, as well as complexity of this basic motor ability. Approximately equal results between the groups were recorded in frequency speed of arms and legs. Results of some studies suggest that the nutritional status is not of great importance for the successful execution of the hand tapping task (Ara et al., 2007; Leskošek et al., 2007; Runhaar et al., 2010). Common characteristic of motor tasks for the evaluation of coordination of arms and legs and frequency speed is their movement structure, which doesn't require greater body shifting and projecting through space. Primarily, for the successful execution of these tasks timing and movement synchronization is important, which largely depends on the maturity of the central nervous system.

CONCLUSION

Our study confirms that overweight and obesity have negative influence on explosive leg strength, coordination and running speed, and positive on explosive arm strength, which is confirmed by other researchers (Ara et al., 2007; Biskanaki et al., 2004; Brunet et al., 2007; Gontarev & Ruzdija, 2014; Leskošek et al., 2007; Riddiford-Harland et al., 2006; Siahkouhian et al., 2011).

Lower results of overweight and obese children, especially in motor tasks that have a higher overall movement that involves lifting and projecting body through space, can refer to the conclusion that lower level of motor abilities is directly influenced by excessive body fat, and indirectly by reduced physical activity in those children.

Preventing obesity in children is of particular importance, since the habits established in this period will most likely continue later in life (Guo, Roche, Chumlea, Gardner, & Siervogel, 1994; Zametkin, Zoon, Klein, & Munson, 2004). Differences in motor abilities can provide some guidance for implementing prevention of obesity and increasing the level of motor abilities in school population. During the realization of physical education program teachers should apply specific procedure in dealing with obese children, in order for these programs to have appropriate positive effects. Regular aerobic activity reduces body weight, improves cardiovascular and respiratory function and increases the level of certain motor abilities, which is why it is necessary to monitor the growth and development of children and enable timely and synchronized reaction of school, parents, medical workers and teachers of physical education and sport.

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GENERAL AND LOCAL INFLUENCE OF SWIMMING ON DISABLED PEOPLE

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SUMMARY

The purpose of this paper is to explore the influence of swimming on disabled people. Swimming is regarded as a natural form of movement with high positive influence on organism, especially on organism in development. Eight papers have been analyzed by both domestic and foreign authors. By applying different tests we got basically the same results. Swimming as a form of recreation has a positive influence on mental and physical development on disabled people. How is this positive influence seen, mostly depends on a type and a degree of disability of people who were involved in this study.

Keywords: water sports, swimming, special rehabilitation, influence on disabled people

INTRODUCTION

The proper approach to physical activities of children and youth with disability implies detailed insight into physical, functional and health condition of individuals. Many factors, which disturb or significantly limit physical activity in disabled people, are present. People with special needs can very much do sports and their participation in different branches of sports helps physical and mental development. Because of the disability in physical and mental development, disabled people need customized approach, in other words, customized physical activity. Group of water sports, which are often applied to disabled people, consists of: swimming, rowing, fishing and their overall effect has a positive influence on blood vessels, heart and lungs, cardiovascular and respiratory function. Swimming with disabled people, as a sport, has been present ever since 1924. Motor transfer of water-earth is long known – brain recognizes the movement. In is easier to move in water. In working with disabled people we apply two customized methods - Halliwick and Sherrill model. Halliwick method is based on scientific principles of hydrostatics, hydrodynamics and mechanics of the body. Method has been developed by James McMillan in 1949. Model implies psychological (mental) and physical adjustment of students to water, achieving the sense of security and comfort in water, relaxation, breathing control, learning how to keep your balance in water. You don't use any tools because they inspire the false sense of security. Another aspect of Halliwick method is that everyone is a swimmer and that by adjusting accordingly to water you can feel good and swim (International Halliwick Association). Halliwick method is considered the most successful and the most promising way for disabled people of any age.

METHODS

Researching literature has been done by the fallowing search engines: MEDLINE, Google Schoolar, EMBASE, KOBSON, PubMed. In order to closely define the search and to limit it only to papers which are the object of this research, the fallowing key words have been used: sports, swimming, special rehabilitation, and influence on disabled people. By advanced search of literature only the papers which have been published in the period from 2000-2014, have been taken into consideration. Other than this, all the references of all the papers have been checked so that we could find additional papers which explored the same of similar topic. For gathering and reviewing the research papers we used descriptive method together with theoretical analysis. This research includes 925 papers related to general influence of sports on disabled people. The 322 papers, closely related to the title, have been carefully analyzed and they also satisfy the criteria based on which the selection has been performed.

Initial research of literature indentified 107 references, which satisfy some of the given criteria of the research; however 99 papers have been eliminated based on selection, key words and other criteria, so the 8 papers are included in analysis.

HYPOTHESIS

Based on the given topic the hypothesis has been defined:

H_1 – Swimming has the general and local influence on disabled people

RESULTS

Studies that dealt with researching the influence on improving the ability of disabled people are numerous. Fragala-Pinkham and associates (2008), as a goal of their study, explored the efficiency and safety of the swimming program and of conducting different activities in water on durability of disabled children. Sixteen children participated in the study ranging from 6-11 years. The program was conducted two times a week for14 weeks. Children swam in circles, they participated in races and games prepared in advanced. Results show significant improvements in the field of walking but not in muscular strength or improving motor skills. Still, general conclusion is that durability in disabled children can be improved after implementing the swimming program.

The goal of the research, conducted by Chryagis and associates (2009), was to exam the influence of 10 weeks long swimming activity on motor skills. Twelve students participated (6 students in experimental and 6 students in control group) who were equal by genre, age and their abilities. Pre-test and post-test have been conducted before and after applied program on experimental and control group of children. The results of this study show that swimming program can have the positive effect on gross motor skills.

Considering that many authors did the research about the direct influence of swimming program to motor ability and that only a few authors dealt with social sphere, Dorval and associates (1996), in their study, researched the relation of self-respect, functional independence and swimming activity. Twenty adolescents with cerebral paralysis, ages from 10 to 17, were involved in the research. Subjects were divided into experimental and control group (10 each). The program lasted for 10 weeks and each session lasted for 55 minutes. Research results show significant differences in the field of functional independence in both groups measured at the beginning of the program and after 10 weeks while the results of measuring were the same in 10th week and after 9 months. While measuring the development of self-respect, from the beginning till the end, both groups showed significant improvement. Between the groups themselves no matter that a different swimming approach has been applied no significant difference has been found in relation to the tested abilities which points out that swimming program, conducted in any form, leads to improvement of abilities in people with cerebral paralysis.

The subject of the research, conducted by Milicevic-Marinkovic and associates (2011), was rehabilitation of autistic children through swimming, while the goal was to determine the effects of three months long swimming training. During the three months long experiment with autistic child, age 13, they reached a positive effect, in other words, the child learned how to swim. The effect of swimming has been determined, from the basic elements to the most complex ones. In this case it means that the child without anybody's help learned how to float on the stomach, float on the back, slide on the water with pushing from the edge of the pool, dive under water, maintain balance on the water, jump from the edge of the pool and to overcame certain distances. Through swimming his motor abilities are improved but also his social integration.

Dimitrios and Dimitrios (2004) conducted the research about the influence of customized program of swimming on people with kyphosis-scoliosis with the use of individual educational approach. The sample was one adult female (31 years) with kyphosis-scoliosis. The participant learned how to float on water horizontally by turning the head and arm in opposite direction from the rotation which is caused by the shape of her body. She got used to the new surrounding, she overcame the fear of water and she managed to build a relationship based on trust between her and her swimming coach.

Swimming of disabled people (handicapped people) is of recent date in our environment and is mostly based on conducting a certain project. One of those projects resulted in six students with disability learning how to swim in classes organized during 2012 within the project "And we can do it". The project has been conducted for four years by The Association of handicapped students of Nis (AHSN) within the program of "Partnership for education and community development" (PECD program) under the sponsorship of Philip Morris Company. In the last season, which started in October of 2011, 15 members of AHSN with the swimming instructor Miljan Perovic, applied this new Halliwick method in swimming with disabled people. It is the innovative method which allows these people to learn how to swim and to move independently through water no matter the age and form of disability. Halliwick is based on known laws of hydrostatics, hydrodynamics and mechanics of the body movement in water, and it implies learning one on one without the use of swimming tools.

The goal of research of Jorgic and associates is to determine the effects of the swimming program on the rough motor function, adjustability to water environment and ability of movement in water and swimming with children with cerebral paralysis. The sample was made from seven children age from 9 years. The swimming program included the application of Halliwick method and swimming exercises which are applied to healthy population. The results showed that applied swimming program had significant positive effects on improvement of the ability to walk, run, jump and overall rough motor function in children with cerebral paralysis. It also significantly contributed to the increase of psychological adjustability to water environment and to improvement of the ability to move in water and to swim.

Author, year , country	Number of subjects (n), age	Purpose of the paper	Results and conclusion
Fragala-Pinkham and Assoc. (2008), USA	n=16, 6-11 years	To test the efficiency and safety of the swimming program and conducting different activities in water with disabled children.	Results show significant improvements in the field of walking but not in muscle strength or improvement of motor skills.
Chryagis and Assoc. (2009), Greece	n=12 (6-E, 6-K), 13-20 years	To test the influence of swimming on motor functions, range of movements and spasticity	Results of the applied swimming program showed the influence of improving motor function, range of movement and reduction of spasticity.
Chryagis and Assoc. (2009), Canada	n=20 (10-E, 10-K), ,10-17 years	To test the relation between self-respect, functional independence and swimming activity.	Improvement of self-respect and functional independence after applied swimming program.
Milicevic-Marinkovic and Assoc. (2011), Serbia	n=1, 13 years	The purpose is to determine the effects of three-months long program of swimming training on swimming abilities of autistic children.	During three-months long period of working with autistic child, who couldn't swim, the swimming training was successfully conducted.
Dimitrios K. and Dimitrios V. (2004) Greece	n=1, 1 year	To determine the influence of customized swimming program on performance of people with kyphosis-scoliosis with the use of individual educational approach.	There was a significant improvement of body posture as well as the attitude towards water.
PECD program (2012), Serbia	n=6, students	The application of Halliwick method with disabled people.	All six students learned how to swim.
Jorgic and Assoc. (2012), Serbia	n=6, 9 years	The purpose of this research is to determine the effects of swimming program on rough motor function, adjustability to water surrounding and ability of movement in water and swimming in children with cerebral paralysis.	Applied swimming program had significant positive effects on the improvement of walking, running, jumping and total rough motor function in children with cerebral paralysis. It also contributed to significant increase of mental adaptability to water surrounding and improvement of the ability to move in water and swim.
Srsen A. (2002), Croatia	n=8, 13 years	The progress of the group was evaluated and it was calculated in which abilities the greatest improvement was achieved.	It was shown that the children in average improved all the abilities from adjusting to water to adopting different kinds of rotations. The greatest improvement was achieved with: breathing control, longitudinal rotation and combined trotation. Slightly smaller improvement was achieved with getting out of water.

DISCUSSION

This paper stated and processed some of the experimental researches of general and local influence of swimming on disabled people. The largest number of subjects is located in the research of Chryagis and Assoc. (2009), and the smallest number in the research of Milicevic-Marinkovic and Assoc. (2011) and Dimitrios K. and Dimitrios V. (2004). The duration of the experiment is mostly reduces to the period of a couple of months. The common thing for all the processed papers is that no matter which method of exercises in water is applied, it has a positive influence on improvement of results and also on progress of disabled people.

CONCLUSION

In every society, even ours, there are many barriers for physical engagement of people with intellectual disabilities: the lack of appropriate exercise program, facilities, equipment, experts, available spots in recreational centers, and thus these people are often unjustly marginalized. Many children and adults with intellectual disability are still greatly socially isolated and faced with negative stereotypes and low expectations which limit them to participate in group physical activities (Stankovic M., Aleksandrovic M. 2012). By the current analysis we reached a conclusion that the advantages of customized swimming programs are numerous and all the researches confirm the positive results of such programs.

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SOMATOTYPE OF ATHLETIC AND NON-ATHLETIC FEMALE STUDENTS

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SUMMARY

Somatotype both reflects the overall image of the human body and emphasizes the entire morphological structure of the human body. Determination of human somatotype increases the knowledge about somatotype variability within one population, the differences between population groups, etc. The purpose of this research was to determine the somatotype of athletic and non-athletic female students, that is, to discover potential differences in certain body constitution components. The group of physically active female students was comprised of 29 subjects, and the group of non-athletes was comprised of 30 female students. 10 anthropometric variables were measured to evaluate somatotypes. Software Somatotype 1.1 (Sweat Technologies) was used to determine both the mean somatotype values in the two groups, and the somatogram. All the data was processed by the statistical software for data analysis called Statistica 6.0. Differences between the groups were determined by the canonical discriminant analysis. The results showed differences in somatotype between athletic and non-athletic female students with statistical significance ($p < .05$; p-level= 0.015). The group of athletes had higher results, which confirmed that physical activity positively affects human somatotype.

Keywords: somatotype, physical activity, inactivity, female students

INTRODUCTION

Nowadays, lack of physical activity is present in every layer of the society. Due to technological advances, people are physically inactive, particularly because they are being replaced by the machines. Lack of movement and insufficient quantity of physical activity also affect man's health status. Physical inactivity is responsible for the development of 15-20% of cardiovascular diseases in Europe, and also of the type 2 diabetes, colorectal cancer, breast cancer and osteoporosis in elderly people (Petrović-Oggiano et al., 2010). Proper frequent physical activity has a special preventive value, which is important not only for keeping the right body mass index, but also for prevention and eradication of diseases (Vračan, Pisačić & Slačanac, 2009). Hackney (2006) suggests that physical activity does not only decrease the subcutaneous adipose tissue, but also helps in gaining the muscle mass, increases the metabolism speed, and affects the hormonal body composition which further prevents excess weight gain.

Sports scientists have dedicated a lot of time to defining the relation between physical characteristics and sport performance. A number of anthropometric surveys have shown that the morphological characteristics of athletes who are successful in different sports are identified by comparing athletes' physical characteristics with the characteristics of those who are not actively engaged in sports, particularly within the frameworks of different sports, or simply by comparing different levels of one single sport (Rahmawati, Budiharjo & Ashizawa, 2007).

Somatotype both reflects the overall image of the human body and emphasizes the entire morphological structure of the human body (Ross et al., 1982). The differences in somatotype that are related to gender are visible from an early age, and they are further exemplified in the period of physical growth and development. Female population shows greater endomorphic development and lesser mesomorphic development in comparison to male population (Jović, Đurašković, Pantelić & Čokorilo, 2010).

Somatotype is presented by numerical values which correspond to its three components: the endomorphic, which represents the development of relative body fat; the mesomorphic, which represents the existence of relative changes in the musculoskeletal system; and the ectomorphic, which represents the body linearity (Jović, Đurašković, Pantelić & Čokorilo, 2010). The case when one component is more dominant than the other components is called "pure types" (endomorphic 7-1-1, mesomorphic 1-7-1 and ectomorphic 1-1-7). The most common constitutional types are those that have characteristics of the two (5-7-1), or all three components (4-4-4). Some authors connect body constitutional types strictly to the genetic basis (Bouchard et al., 1980), while others consider that the nature of somatotype is prone to change during lifetime under the influence of a number of internal and external factors: sex, age, nutrition, training, physical activity, diseases and other. A lot of research has shown that somatotypes have strong genetic bases (Harrison, Weiner & Tanner, 1976).

Somatotype based research increases the knowledge of somatotype variability within one population group, shows the differences between population groups, etc. (Jović, Đurašković, Pantelić & Čokorilo, 2010). In their study, Gualdo & Graziani (1993) both analyzed and described somatotype of 1593 young Italian athletes (717 male and 876 female athletes) who were actively engaged in different sports. The average male somatotype was 2.7-4.7-2.7 and the average female somatotype was 3.6-3.7-2.8. The survey of Amus and Oneivadume (2001) based on Botswana karate team members, which was performed as an integral part of the African Games preparation in 1999, showed that the somatotype in men was 2.5+1.1-3.9+0.9, and in women it was 4.4+0.8-4.7+1.2-1.3+1.1 (endomorphic, mesomorphic and ectomorphic).

One universal male or female constitutional body type cannot be defined. It is known that constitutional types are independent of gender, while all constitutional types are present in both sexes.

People with different somatotypes show unique performance ability during exercise and physical training (Bolonchuk, Siders, Lykken, & Lukaski, 2000). Different anthropological surveys, which were performed on the Olympic athletes, consistently showed that athletes active in the same sports had similar somatotypes despite their geographical, cultural or economic background, while the athletes who were active in different sport disciplines had different somatotypes (Carter, 1970, 1984; de Garay et al., 1974). Different analyses have shown that somatotypes are prone to change when they are influenced by life styles and biological acceleration (Mišigoj-Duraković, 2008).

Certain authors also stress that the body constitution and composition are greatly determined by the level of physical activity. The relation between muscular mass and body fat is an important indicator of the level of body readiness to achieve maximum results; however, it is also an indicator of different health risks (Hausman et al., 2001; Greenlund & Nair, 2003).

The purpose of this research was to determine the somatotype of athletic and non-athletic female students, that is, to discover potential differences in certain body constitution components.

METHODS

Subjects

The sample was composed of 59 female students, aged 20 to 25 years. The subjects were divided into two groups. The first group was comprised of 29 physically active female students. The subjects were considered physically active if they exercised some aerobic activity at least three times a week, for at least six months. The second group was comprised of 30 physically inactive female students. Physical inactivity did not only mean the lack of activity; instead, it was a collection of behaviors at work, in school, in the house or in transportation, which were dominated by actions such as sitting or lying down – the activities which require little amount of energy. Typically, such behavior included watching television, working on a computer, travelling by car, bus or train from home to school or work, sitting and reading, chatting, doing homework or listening to music.

Procedure

The endomorphic, mesomorphic and ectomorphic somatotype components were calculated according to the Heath-Carter's method (Carter & Heath, 1992). The sum of upper arm, back, stomach and lower leg skin folds were used to determine the endomorphic somatotype component. The mesomorphic somatotype component was determined by measuring body height, knee and elbow diameter, the volume of the upper arm in flexion, and the volume of the lower leg. The ectomorphic somatotype component was determined by the relation between body height and body mass, using Ponderal Index: body height $/\sqrt[3]{\text{body mass}}$.

The average somatotype for both groups and their somatograms were measured by the software Somatotype 1.1 (Sweat Technologies).

Statistical analysis

Descriptive statistics basic parameters were calculated for each of the measured anthropometric segments and somatotype components (the average value – Mean; the minimum value – Min; the maximum value – Max; and the standard deviation -

SD). The differences between the groups were determined by the canonical discriminant analysis.

All the data was analyzed by the statistical package for data processing Statistica 6.0, while the level of statistical significance was 0.5.

RESULTS

Table 1 - Descriptive statistics parameter values of somatotype components in athletic and non-athletic female students

	Athletes (n=29)					Non-athletes (n=30)				
	Mean	SD	Min	Max	Range	Mean	SD	Min	Max	Range
Body weight	60,62	5,71	53,0	73,5	20,5	59,43	6,32	47,00	71,60	24,60
Body height	164,42	6,02	157,0	181,6	24,6	165,31	6,10	156,20	178,50	22,30
Back skin fold	13,19	4,38	7,6	24,0	16,4	12,03	3,56	7,40	20,40	13,00
Upper arm skin fold	14,54	4,14	7,8	24,4	16,6	13,91	2,47	9,00	21,50	12,50
Stomach skin fold	18,41	8,22	8,0	38,6	30,6	15,28	5,84	7,10	30,20	23,10
Lower leg skin fold	14,91	3,35	9,40	23,60	14,20	18,44	5,17	8,13	31,17	23,04
Elbow diameter	6,12	,22	5,8	6,8	1,0	6,14	0,22	5,80	6,60	0,80
Knee diameter	9,00	,33	8,6	10,0	1,4	9,05	0,33	8,60	9,80	1,20
Upper arm volume in flexion	27,99	3,52	19,8	36,4	16,6	27,06	1,63	24,50	30,50	6,00
Lower leg volume	36,57	1,51	34,0	39,3	5,3	34,91	1,77	34,91	38,50	7,00
ENDOMORPHIC	4.66	1.09	3.00	7.00	4.00	4.22	3.50	5.00	1.50	0.55
MESOMORPHIC	4.26	0.83	2.51	6.01	3.50	3.72	2.43	4.67	2.24	0.56
ECTOMORPHIC	2.19	1.02	0.10	4.50	4.40	2.52	0.69	4.23	3.54	0.89

Legend: n-the number of subjects; Mean-the average value; Min-the minimum value; Max-the maximum value; Range-the range of values; SD-the standard deviation

The values in Table 1 showed that the values in almost every parameter of athletic female students were higher in comparison to non-athletic female students. The values suggested that the athletic students had a dominant endomorphic component (4.66); nevertheless, similar values were found for non-athletic students (4.22). The mesomorphic component in athletic students was higher in comparison to the non-athletic students (4.26 and 3.72). In both groups the value of ectomorphic component was lower than the values of the other two body constitution components. This suggested that the subjects of the both groups belonged to the endo-mesomorph constitutional body type, that is, muscle mass was dominant in the body composition of all subjects. There were some striking differences in the minimum and maximum values (Range) which were present in all somatotype components, which further suggested a high level of heterogeneity in the sample of the both groups. The values of the ectomorphic component, which expressed body linearity, were higher for non-athletic students (2.19 and 2.52), which further suggested that these subjects had proper concentrations of both muscle mass and body fat. Athletic students had greater values of both muscle mass and body fat parameters.

The differences between the groups were determined by the canonical discriminant analysis.

Table 2 – The importance of the isolated discriminant function

Eigen-	Canonical R	Wilks'	Chi-Sqr.	df	p-level
0.21	0.41	0.83	10.47	3	0.015

Legend: Eigen-the inherent Eigen value (intrinsic value, characteristic root); Canonical R–the canonical correlation coefficient; Wilks'-discriminative power of the variables; Chi-Sqr.-Bartlett's test value; df-the degree of freedom; p-level-the level of importance

Based on the results, it could be concluded that the entire system of measured anthropometric segment values had statistically relevant differences for the two groups (p-level=.015), which further suggested the existence of relevant differences between the groups. The canonical discriminant analysis showed that there was one significant discriminative function which had statistically high discriminative power and which explained 17% ($0,17=0,41^2$ coefficient of discrimination) variance of the dependant variable (active/passive) with 41% (Canonical R= .41). Discriminative power of the variables expressed through the test (Wilkins' lambda distribution) was not high (.83), so a certain percentage of the wrongly classified students can be expected. This confirmed that statistically relevant data about the differences between athletic and non-athletic female students really exists.

Table 3 – The structural factor of the isolated discriminant function

	Root 1
ENDOMORPHIC	0.57
MESOMORFPHIC	0.86
ECTOMORPHIC	-0.38

Table 3 showed the structure of the discriminant function variable of the athletic and non-athletic constitutional types, which was relevant for establishing significant discriminant functions. In this case, the groups' centroids represented the arithmetic means of the somatotypes in groups of athletes and non-athletes. The analysis of the structural factor of the isolated discriminant function showed that the mesomorphic component gave the greatest value to the discriminant function (MESOMORPHIC=0.86).

Table 4 – The groups' centroids

	Root 1
G_1:1	0.46
G_2:2	-0.44

Table 4 showed the groups' centroids which were considered the somatotype arithmetic means of the athletes and non-athletes. The results showed that the level of their discrimination (decomposition) was high and relevant, going from 0.46 to -0.44, which also meant that these values affected decomposition results in the active and the inactive group.

Table 5 – The precision of result classification

	Percent	G_1:1	G_2:2
G_1:1	62.07	18	11
G_2:2	70.00	9	21
Total	66.10	27	32

A successful division between the physically active group and the inactive group was presented in percentages in Table 5. The results explained that the mentioned discrimination (decomposition) was carried out with precision of 66.10%.

DISCUSSION

Based on the results, it could be concluded that there was a statistically relevant difference (p-level=.015) in the somatotype of the athletic and non-athletic female students. The difference was in favor of the physically active students. Based on the results in Table 3, it could be seen that the greatest difference was in the value of mesomorphic component, and that the physically active students had higher values. When talking about higher values of the mesomorphic component in physically active female students, such result were expected. A similar study of Rousanoglou, Nikolaidou & Boudolos, (2006) came to similar results which showed that physical activity leads to greater muscular mass. The results of each and every body constitution component, both in active and inactive students, showed that both groups belonged to the endomorph-mesomorph constitutional type. The endomorphic somatotype component was dominant in both groups, while the value of mesomorphic component was higher than the ectomorphic component. This suggested that both the muscle mass and the subcutaneous adipose tissue were in balance, while their values were higher in physically active students. This could be explained by the fact that the survey did not focus on the intensity of the physical activity; on the contrary, the subjects were classified in groups according to exercise frequency and duration (the subject had to be physically active three times a week in the last six months, approximately 60 minutes per exercise). The survey of Malousaris (2008), which questioned the somatotype of female volleyball players, also found a higher value of endomorphic than the mesomorphic component in the subjects of the physically active group. Similar results can be found with the subjects of other researches (Srdić, Dimitrić, & Obradović, 2009).

Recent research has shown that there is a difference in morphological characteristics and health status of women who are physically active and those who are physically inactive (Čokorilo, et al, 2014). Stewart et al. (2003) analyzed the somatotypes of men and women athletes and non-athletes. The average values of certain body constitutional components in women who were non-athletes (4.7-3.7-2.5) were similar to the values of the subjects included in this survey and who were physically inactive. Certain values of the athletic subjects were 3.6-5.0-1.3, which means that their mesomorphic values were higher and their endomorphic and ectomorphic component values were lower than the values of the subjects included in this survey who were physically active.

The somatogram of the groups' somatotypes made analysis of the differences between the groups' somatotypes easier. As the results have shown, both the athletic and the non-athletic female students belonged to the endomorph-mesomorph constitutional type; however, it should be noted that the results of the mesomorphic component in physically active students was significantly different due to their greater muscular mass.

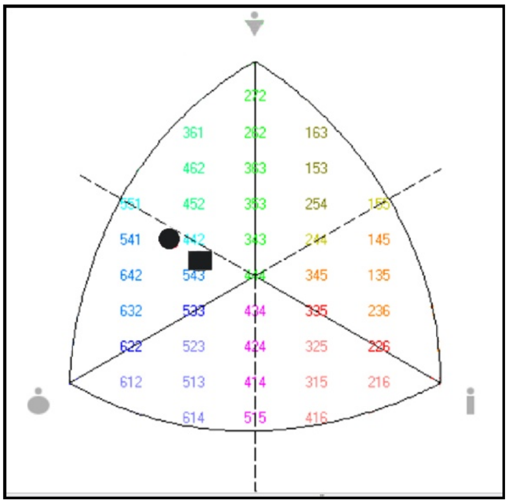

Figure 1 – The somatogram of the athletic and non-athletic female students

- ● The group of athletes
- ■ The group of non-athletes

The study of Noh, Kim & Kim (2013) also got higher values of the endomorphic and mesomorphic component in the groups of physically active people in comparison to those who were physically inactive. As in this survey, the reason for this was greater muscular mass of physically active people, that is, their body constitution and body composition were greatly determined by the level of their physical activity (Srdić, Dimitrić, & Obradović, 2009).

CONCLUSION

Somatotype both reflects the overall image of the human body and emphasizes the entire morphological structure of the human body. The results of certain body constitution components, both in athletic and non-athletic female students, showed that both groups belonged to the endomorph-mesomorph constitutional type. Based on the results it could be concluded that there were statistically relevant differences in somatotype of the athletic and non-athletic female students, that is, physically active female students had greater mesomorphic component which also suggested greater muscular mass. Apart from its basic positive effects on the human body, physical activity also increases the muscular mass, and therefore increases the mesomorphic component. It can be said that the body constitution and body composition are very much determined by the level of physical activity.

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THE BASIC PRINCIPLES OF THE PARALYMPIC SPORT BOCCIA

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SUMMARY

Boccia is a ball-throwing sport intended for persons with cerebral palsy or similar disease which necessitates a wheelchair. It is very similar to bocce and bowls. Its early forms are believed to have originated in ancient Greece, where contestants would throw large rocks at a target rock. Boccia is one of the sports available to disabled persons using a wheelchair. The possibilities of application for boccia are endless. There are no health risks associated with this sport. Boccia is not expensive (all the equipment required is a set of balls and a wheelchair). It can be played just as easily indoors and outdoors. Its rules are not difficult to acquire. All this recommends it as an excellent sport to be included in Serbian schools so all children could learn how to play it. This would facilitate the integration of disabled children into normal social life.

Keywords: boccia, basics, rules, inclusion

INITIAL CONSIDERATIONS

The term "adapted physical activity" refers to physical activity which has been adapted or modified according to the needs of people with disabilities (Winnick, 2011). Although numerous studies indicate that there are multiple benefits to be gained by this population from practicing some sort of physical activity, the situation is quite different in practice (Veličković et al., 2013). Studies conducted by the World Health Organization indicate that, out of the total number of disabled persons registered in a WHO-member country, only up to 0.2% engage in some type of physical activity (Vuković, 2013). For this reason, persons with a disability should be guided toward physical activity from childhood. Furthermore, a number of studies stress the significant physical inactivity in wheelchair-using children (Eminović et al., 2010).

When it comes to physical activities for persons using a wheelchair, there are a number of sports, disciplines and activities available (Ђурашковић & Живковић, 2009; Canales & Lytle, 2011). Within the Paralympic sports program alone, wheelchair-users can take part in the following: skiing, archery, athletics, biathlon, boccia, canoeing, cycling, equestrian sports, ice hockey, weight-lifting, rowing, sailing, archery, sitting volleyball, swimming, table tennis, wheelchair basketball, wheelchair dancing, wheelchair curling, wheelchair fencing, wheelchair rugby and wheelchair tennis.

As noted above, boccia is one of the sports available to disabled persons using a wheelchair. The rest of this paper will consider some of the basic principles of this sport and the possibilities for its application.

A short history of boccia

Boccia is a ball-throwing sport intended for persons with cerebral palsy or similar disease which necessitates a wheelchair. It is very similar to bocce and bowls. Its early forms are believed to have originated in ancient Greece, where contestants would throw large rocks at a target rock. It had been a recreational pastime for a long time before it was proposed and subsequently included as a competitive sport at the Paralympics in New York in 1984.

Boccia is nowadays practiced in over 60 countries across the world and is fast becoming one of the more popular sports for disabled persons (DP).

Only 17 players took part in the 1984 presentation of this sport at the New York Paralympics. At the following Paralympics, in Soeul in 1988, only BC1 and BC2 athletes participated. At the Paralympics in Barcelona in 1992, the competition was divided into three categories. The first category is BC1 mixed and individual, the second BC2 mixed and individual, and the third included mixed teams from BC1 and BC2. Next, in Atlanta in 1996 contestants from the BC3 category joined in (contestants who are not able to lift and grip the ball, but instead rely on a ramp which their assistants, allowed for in the sport, help them to hold and direct). At the 2000 Sydney Paralympics the competition included individuals, pairs and teams. Men and women compete together. Contestants from the BC4 category (able to throw a ball, but not above the shoulder level) and pairs both joined in at the 2004 Paralympics in Athens. Growing interest in the sport was noticeable also at the 2008 Paralympics in Beijing, where 20 countries and 88 contestants took part.

The first World Cup was held in Coimbra in 1991. The first World Championships took place in Gits in 1986, and the first European Championships in 1993 in Antwerpen.

Outside the US, boccia is dominated by teams from Thailand, Korea, Great Britain, China and Japan.

Fifteen delegates from seven countries took part in a project aimed at making boccia available to everyone. The project was presented in Johannesburg at the beginning of 2015. Its objective is to help spread boccia to those parts of the world where it is yet to develop. The delegates learned both how to play the game and how to teach others how to play it. During the workshop, they learned about the basic rules, tactics, as well as how to referee.

THE FUNDAMENTALS AND BASIC RULES OF BOCCIA

Precision and technique, rather than strength and size, are what matters in boccia. This may not be a dynamic sport, but it is still very interesting for players and observers alike.

The basic equipment for this sport comprises balls (in red and in blue) which the athletes throw, as well as a white ball (the "jack") which serves as the target. In addition, depending on the category, an assistive ramp may be required, which enables players otherwise unable to hold a ball to still throw it at the target. There are three players on each team, each of which gets 2 throws. The team assigned red balls opens by throwing the white ball, which needs to land within a designated portion of the field. The team who throws the white ball is also the first to throw the colored ball.

The main aim in this sport is to get the ball to land closer to the jack than that of one's opponent, in which case a point is assigned. Within one round, six points can be won.

Athletes are divided into categories (BC1, BC2, BC3, BC4). They can compete individually, in pairs or in teams.

Any category can participate in individual competitions, so long as the opponents are in the same category. In paired competitions only BC3 and BC4 categories may take part, with two athletes allowed on the field at the same time, and one substitution allowed. The categories BC1 and BC2 contest in teams, with two athletes in the box simultaneously and two substitutions allowed.

This is a very interesting sport of increasing popularity, since it does not require any significant investment. The field is simple to demarcate, and the referees require only one meter. Contests can take place both in sports halls and outdoors. The field needs to measure 12.5 by 6 meters. Each field comprises six boxes that contain the players during the contest. The dimension of one box is 2.5m. The surface itself can be wood, plastic, or made from materials used in sports halls.

BOCCIA CLASSIFICATIONS

Prior to the contest, players are classified into four groups: BC1, BC2, BC3 and BC4. Classification is conducted according to regulations specified in the technical rulebook CP-ISRE.

Table 1. Boccia classification.

Classification groups	A description of athletes within the classificaion group
BC1	Players throw the ball (CP1) or kick it (CP2). They can contest with the aid of an assistant who remains outside the box, and helps adjust the wheelchair or pass the ball at the player's request.
BC2	Players in this category can throw the ball using their hands. They do not require assistance.
BC3	Players in this category have significant locomotor dysfunction in all four extremities. The require assistive devices like a ramp for throwing the ball.
BC4	Athletes in this category have significant locomotor dysfunction in all four extremities. The throw the ball from a low point, as they are unable to make a throw where their elbow would rise above the shoulder level.

INCLUSION POSSIBILITIES BY MEANS OF BOCCIA (OR, IN LIEU OF A CONCLUSION)

The possibilities of application for boccia are endless. There are no health risks associated with this sport. Boccia is not expensive (all the equipment required is a set of balls and a wheelchair). It can be played just as easily indoors and outdoors. Its rules are not difficult to acquire. All this recommends it as an excellent sport to be included in Serbian schools so all children could learn how to play it. This would facilitate the integration of disabled children into normal social life.

On the other hand, it would enable their peers (typically developing children) to become acquainted with the characteristics and way of life of people with disabilities early on, and to come to accept them naturally and with no hindrances. Through competing together they would learn cooperation, personal assistence and tolerance.

Above all, however, the main prerequisite for successfully introducing boccia is training teachers on the basic principles of this sport, as the catalysts for inclusion in physical education (Đorđić, & Tubić, 2012). In addition to ongoing education of all those working in schools and sports centres, it would also require students of physical education to adopt the principles of this sport in the course of their studies.

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PREDICTING RESULTS IN FREESTYLE DISCIPLINES AT THE 2016 PARALYMPIC GAMES FOR SWIMMERS WITH A PHYSICAL DISABILITY

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SUMMARY

In Paralympic swimming, it is therefore necessary to know and be able to predict what sports achievement in particular is required for winning a medal in a certain competition. In order to win a medal in such a sports event, one must be familiar with the trends in the results so far achieved as well as be able to predict the results to be achieved in the next competition. The objective of this paper is to identify the trend in results development for freestyle Paralympic swimmers with a physical disability and to predict the results to be achieved in freestyle by athletes with a physical disability at the next Paralympics. In order to meet the objective of the study, first a database of all results achieved in the last five Paralympics by medal winners was created – for swimmers with a physical disability in 50m and 100m freestyle. Only the results achieved in men's categories and relating to physical disability, S2 through S10, were considered. The overall impression is that there has been consistent improvement in medal-winners' swimming results across all the categories studied at 50m and 100m freestyle in the last five Paralympics. Based on the development trend identified for the results achieved by medal-winners', a model of result prediction was built for potential medal-winners at the next Paralympics in Rio de Janeiro in 2016. The tool used to this end was the quadratic regression analysis model. This study's contribution lies in its being able to provide answers for Paralympic swimming coaches in terms of the result their swimmer will need to achieve in order to be be in contention for a medal.

Keywords: trends, predicting, Paralympics, swimming.

INTRODUCTION

To ensure fair and equal chances in contests, there is a system in place in all Paralympic sports ensuring that winning is based on skill, fitness, strength, endurance, tactical ability and mental focus (Howe & Jones, 2006; Purdue & Howe, 2013). These are the same factors which also determine success in sports for people without disability (Howe & Jones, 2006; Tweedy & Vanlandewijck, 2011). This holds in Paralympic swimming as well (Daly et al., 2001; Daly et al., 2003; Fulton et al., 2009a). The process is termed classification. On the other hand, the effect of the disability on the sport has to be demonstrated. In any Paralympic sport, the criterion for grouping athletes based on the degree of disability is termed „sports category" (Oh et al., 2013). Based on Paralympic swimmer categories/ classifications, athletes' eligibility for contesting and classification within the contest was determined. Three types of disability are considered in swimming: physical, visual and mental (Wu & Williams, 2010).

Throughout Paralympic history, the classification system for Paralympic swimming changed frequently (Daly & Martens, 2011). The high number of swimmer categories, and in turn of disciplines, complicated the organization of swimming competitions. Since the 1996 Paralympics in Atlanta, a single system has been in use. Of the total 14 categories ten relate to physical disability, and these are the categories with the greatest number of swimmers (Daly et al., 2000).

The terms for sports categories in swimming consist of the prefix "S","SM", or "SB", followed by a number. The prefix refers to the discipline (that is, style), whereas the number relates to the sports category the athlete is competing in (S – crawl, butterfly and backstroke, SM – medley, and SB - breaststroke). The lower the number, the higher the degree of disability, and vice versa.

Paralympic swimmers' approach to training is no different than that of Olympic swimmers. In all major competitions (Paralympic Games, World Championships, European Championships), the norms for contesting are becoming stricter. In addition, limits are being pushed in terms of results achieved from one contest to the next (Fulton et al, 2009b; Fulton et al, 2010; Burkett et al., 2010). It is therefore necessary to know and be able to predict what sports achievement in particular is required for winning a medal in a certain competition. The Paralympics, as a central sports event for people with disabilities, the culmination of a four-year cycle of training planning, represents the crowning achievement for any Paralympian. In order to win a medal in such a sports event, one must be familiar with the trends in the results so far achieved as well as be able to predict the results to be achieved in the next competition.

The objective of this paper is to identify the trend in results development for freestyle Paralympic swimmers with a physical disability and to predict the results to be achieved in freestyle by athletes with a physical disability at the next Paralympics.

The overall impression is that there has been consistent improvement in medal-winners' swimming results across all the categories studied at 50m and 100m freestyle in the last five Paralympics.

METHODS

Procedure

In order to meet the objective of the study, first a database of all results achieved in the last five Paralympics (1996, Atlanta; 2000, Sydney; 2004, Athens; 2008, Beijing; and 2012, London) by medal winners was created – for swimmers with a physical disability in 50m and 100m freestyle. Only the results achieved in men's categories and relating to physical disability, S2 through S10, were considered.

Based on the development trend identified for the results achieved by medal-winners' (swimmers with a physical disability competing at 50m and 100m freestyle in the five most recent Paralympics), a model of result prediction was built for potential medal-winners at the next Paralympics in Rio de Janeiro in 2016.

A trend has been identified regarding the development of results for PG 50m freestyle for swimmers with a physical disability. Namely, the result achieved by medal-winning swimmers with a physical disability in 50m freestyle at the next PG will be an improvement compared to the results achieved at the last five PGs.

Statistical analysis

The tool used to this end was the quadratic regression analysis model. Prediction of the most probable results of the medal winners at the Paralympic Games 2016 has been done by approximation of the chosen segment of results by exponential function.

RESULTS

The overall impression is that there has been consistent improvement in medal-winners' swimming results across all the categories studied at 50m freestyle in the last five Paralympics (Table 1).

Still, in 18% of cases (19 out of 108 swimmers) medal-winning athletes' time was in fact slower compared to the result achieved by corresponding medal-winners in the previous PG. This, however, is mainly the case in lower (S2-S4) and medium (S5-S7) categories, where the degree of physical disability is rather high. The short distance and short duration of the race in 50m freestyle is one reason why such isolated cases occurred. This is a sprint discipline decided by speed, an ability known to be affected minimally by training.

As in the previous case, the overall impression is that there has also been consistent improvement in medal-winners' swimming results across all categories studied at 100m freestyle in the last five Paralympics (Table 2).

Here, however, it was only in 7% of the cases (8/108) that the medal-winning swimmers made slower time compared to corresponding medal-winning results in the previous PG. Once again, this was mainly the case in lower (S2-S4) and medium (S5-S7) categories, where the degree of physical disability is rather high. Yet, the significantly lower number of cases at 100m freestyle where medal winners had achieved slower times compared to the corresponding medal-winners in the previous Paralympics speaks to the crucial effects of training, and of the attendant planning, programming and diagnostics on improving the results achieved.

Table 1. A representation of the results achieved at 50m freestyle by medal-winning S2-S10 category swimmers in the five most recent PGs.

PG	Class S2			Class S3			Class S4			Class S5			Class S6			Class S7			Class S8			Class S9			Class S10		
	G	S	B	G	S	B	G	S	B	G	S	B	G	S	B	G	S	B	G	S	B	G	S	B	G	S	B
1996	74,59	77,63	79,19	51,95	57,78	57,8	41,85	42,62	44,83	37,52	38,73	39,86	31,26	31,41	33,22	30,81	31,23	31,28	28,84	29,83	29,85	28,09	28,12	28,16	26,52	26,60	26,82
2000	60,11	68,19	77,77	50,19	53,87	55,68	38,84	39,86	41,62	34,47	36,79	36,80	31,31	**31,61**	31,62	28,58	28,90	29,34	27,93	28,56	29,00	**26,36**	27,17	27,67	25,37	25,51	25,89
2004	**66,87**	**69,18**	69,86	45,65	49,78	50,22	35,41	**37,54**	39,51	32,62	33,63	35,65	30,8	**31,37**	31,90	**28,77**	28,80	**29,71**	26,84	27,54	28,42	**26,37**	26,82	26,88	24,71	25,52	25,61
2008	64,85	65,15	66,09	42,60	44,19	45,75	**37,89**	**38,69**	39,35	**33,00**	33,56	33,78	29,78	**30,07**	31,07	27,95	28,60	28,81	26,45	26,89	27,18	25,34	**25,51**	25,6	23,61	24,64	24,65
2012	61,39	62,47	64,86	39,45	40,19	41,96	**38,26**	**38,75**	**39,47**	32,05	33,44	33,69	29,9	**30,27**	31,43	27,84	28,09	28,47	25,82	26,29	26,31	25,13	**25,75**	25,93	23,16	23,58	23,89
2016	59,06	58,52	59,45	36,19	35,70	37,80	36,01	36,82	37,06	30,21	31,09	31,35	29,34	29,80	30,61	26,82	27,15	27,68	24,92	25,20	25,48	24,18	24,75	24,89	22,13	23,10	23,24

Legend: **PG** – Paralympic Games, **G** – gold, **S** – silver, **B** - bronze

NB: The times in bold are those slower compared to the same medal at previous PG.

Table 2. A representation of the results achieved at 100m freestyle by medal-winning S2-S10 category swimmers in the five most recent PGs.

ПОИ	Класа S2			Класа S3			Класа S4			Класа S5			Класа S6			Класа S7			Класа S8			Класа S9			Класа S10		
	З	С	Б	З	С	Б	З	С	Б	З	С	Б	З	С	Б	З	С	Б	З	С	Б	З	С	Б	З	С	Б
1996	161,94	164,18	164,5	119,21	119,82	121,97	91,35	93,44	99,94	81,61	82,51	85,91	68,45	69,96	74,55	67,13	68,29	68,60	63,87	64,06	65,34	61,04	61,09	61,69	57,26	57,86	58,13
2000	130,48	145,73	153,67	114,14	119,28	121,89	85,92	92,17	94,75	77,94	79,57	84,18	68,10	**70,60**	70,70	63,36	65,00	65,06	62,50	63,46	64,57	58,62	60,27	60,58	54,30	55,46	56,83
2004	**141,49**	**147,46**	149,07	103,51	108,00	115,79	79,51	84,62	86,58	73,39	76,29	77,62	67,60	69,04	69,47	61,65	64,22	65,02	59,83	60,37	63,12	58,15	58,74	59,21	53,73	56,32	56,47
2008	138,04	143,63	144,32	95,21	95,65	104,22	**84,67**	**86,62**	**86,75**	71,05	72,73	75,31	65,95	66,42	68,63	60,35	62,40	64,17	58,84	59,01	59,14	55,30	56,13	56,80	51,38	54,22	54,26
2012	123,71	136,46	141,04	87,36	89,74	101,13	84,28	85,33	85,76	69,35	**74,78**	75,7	65,82	67,34	68,01	**60,57**	61,38	61,50	56,58	57,52	58,33	**55,84**	56,46	56,69	51,07	52,42	52,77
2016	118,46	130,23	133,64	79,10	81,36	95,20	80,53	81,91	79,85	65,245	70,49	70,96	64,96	65,85	65,73	57,77	59,33	60,34	54,85	55,63	56,27	53,67	54,52	54,86	48,96	51,62	51,71

Legend: **PG** – Paralympic Games, **G** – gold, **S** – silver, **B** - bronze

NB: The times in bold are those slower compared to the same medal at previous PG.

DISCUSSION

The improvement in results, even at such short distances as 50m, is determined by identifiable causes. First of all, the selection pool out of which swimmers were chosen had been consistently growing. In addition, a large number of swimmers with disability, especially those in the middle (S5-S7) and higher categories (S8-S10), trained in inclusive clubs, that is, alongside swimmers without disability, which consistently stimulated them to do their best both in practice sessions and in (inclusive) contests. The interdisciplinary approach, with the participation of experts from various scientific areas (psychology, physiotherapy, sports medicine) and sport-related professions (swimming coaches, fitness coaches in the water and on dry land), had as a consequence an enhancement of swimming results.

The model for predicting the results of potential medal winners in the next PG was built by means of quadratic regression analysis. Based on this model, it was established that in each category in the 50m and 100m disciplines there was a prediction for result improvement (Formula 1.).

$$m = \frac{\sum_{i=1}^{n}\left(x_i - \overline{X}\right)\left(y_i - \overline{Y}\right)}{\sum_{i=1}^{n}\left(x_i - \overline{X}\right)^2}$$

Formula 1. *Prediction of the most probable results of the medal winners at the Paralympic Games 2016 has been done by approximation of the chosen segment of results by exponential function.*

CONCLUSION

The objective of this paper was to explore the trend in PG freestyle result development in swimmers with a physical disability and to predict the results to be achieved in freestyle at the next PG by medal winners with a physical disability.

In view of the study conducted, the following conclusions are put forward:

1. A trend has been identified regarding the development of results for PG 50m freestyle for swimmers with a physical disability. Namely, the result achieved by medal-winning swimmers with a physical disability in 50m freestyle at the next PG will be an improvement compared to the results achieved at the last five PGs.
2. A trend has also been identified regarding the development of results for PG 100m freestyle for swimmers with a physical disability. The result achieved by medal-winning swimmers with a physical disability in 100m freestyle at the next PG will be an improvement compared to the results at the last five PGs.

This study's contribution lies in its being able to provide answers for Paralympic swimming coaches in terms of the result their swimmer will need to achieve in order to be be in contention for a medal.

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PHYSICAL ACTIVITY AND HEALTH IMPROVEMENT IN PERSONS WITH SPINAL CORD INJURY

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SUMMARY

Spinal cord injury is one of the most severe types of disability and results in an incomplete to complete loss of somatic, sensory, and autonomic functions below the lesion level. Due to the lack of mobility this population has been characterized as an extremely sedentary. This physical deconditioning causes or contributes to lifelong medical complications such as accelerated cardiovascular diseases, diabetes, osteopenia, visceral obesity, immune system dysfunction, and accelerated aging. Physical activity can play an important role in improvement of health status and in minimizing the incidence of development of the other chronic diseases which certainly follow the spinal cord injury. It can be the basis for improvement of life satisfaction and positive psychosocial aspects of life in persons with spinal cord injury. Physical exercise has to be carefully prescribed in order to avoid possible negative effects of inappropriate physical exercise. Despite the fact that persons with spinal cord injury are faced with certain physical and psychosocial barriers in their environment, limitations can be exceeded, and medical and physical activity professionals can take an essential role in that process. In order to support and enhance physical activity engagement of persons with spinal cord injury the efforts should be focused on health promotion, accessibility and availability of fitness facilities and exercise equipment, as well as physical activity professionals to advice on appropriate exercise program. In line with that, fitness centers are aimed to become the future centers of health promotion for people with disabilities including persons with spinal cord injury.

Keywords: spinal cord injury, disease, disability, physical activity, health.

INTRODUCTION

Spinal cord represents the part of central nervous system and it is the main pathway for information connecting the brain and peripheral nervous system. It has a function in transmission of sensory information, motor control and autonomic regulation.

When the spinal cord is damaged, communication is disrupted between the brain and parts of the body that are innervated at or below the lesion level. The amount of functional loss depends upon the level of injury and on the neurological completeness of the injury. In general, the higher on the spinal cord the injury occurs, the more dysfunction the person will experience. According to Crewe & Krause (1979) individuals with neurologically complete injuries have more severe and more predictable patterns of functional impairment. Depending on the lesion level, the damage of spinal cord injury (SCI) may result in loss of motor function, loss of sensory transmission and loss of autonomic regulation.

The most pronounced consequences are reflected in paralysis of the limbs and distorted sensibility and proprioception, as well as in the disturbances in thermoregulation, cardio-respiratory response, and intestinal, urinary and sexual function. Considering this SCI can be thought as a serious medical condition with considerable functional, psychological, and socioeconomic consequences (Myers & Kiratli, 2007).

The person with spinal cord injury is affected in several ways, and faced with lots of limitations during the healing process immediately after the injury, and in the person's life situation following it. The limitations are both physical and psychological in nature, but some that can be overcome are environmental and practical (Siosteen et al., 1990).

Physical activity (PA) and healthy lifestyle may have essential role in overcoming those limitations from physical, psychological and social aspects.

Etiology, incidence and types of SCI

Spinal cord injuries are more often traumatic, caused by lateral bending, dislocation, rotation, axial loading, and hyperflexion or hyperextension of the cord. Motor vehicle accidents are the most common cause of SCIs, while other causes include falls, work-related accidents, sports injuries, and violence (Bogdanov, 2009).

Causes of SCI classified by age state that motor vehicle crashes are the most frequent causes of SCIs in young and middle-aged persons, but falls are significantly more common in patients older than 65 years (Pickett et al., 2006).

SCI can also be the consequence of non-traumatic causes such as cancer, infection, intervertebral disc disease, vascular diseases, myelitis and others (Van Den Berg et al., 2010).

Spinal cord injury results in an incomplete to complete loss of somatic, sensory, and autonomic functions below the lesion level. When the injury is defined as a complete, that term describes absence of sensory and motor function below the lesion level. Incomplete injury describes partial preservation of sensory and/or motor functions below the neurological level. Loss of autonomic function depends on the lesion level. Lesions in the cervical (C) region (C_1 – C_8) typically result in tetraplegia, whereas lesions in the thoracic (T) region (T_1 –T_{12}) and lumbar (L) regions (L_1 – L_5) lead to paraplegia. Thy injury can also occur in the sacral (S) region (S_1 – S_5) and those injuries generally result in some loss of function in the hips and legs. Tetraplegia usually results in an impairment of function in the arms as well as in the trunk, legs and pelvic organs. Paraplegia is defined as an impairment or loss of motor and/or sensory function in thoracic, lumbar or sacral segments of the spinal cord. With paraplegia, depending on the level of injury, the trunk, legs and pelvic organs may be involved, while the arms function stays undamaged (Jacobs & Nash, 2004).

Statistic says that approximately 50% of those with spinal cord injury have tetraplegia, and 80% are male (Steadward, 1998).

Primary and secondary consequences of SCI

SCI in most of the cases primarily results in inability to move independently which inevitably involves the use of specialized equipment such as manual and/or electrical wheelchairs, crutches and other assistive devices. Due to the lack of mobility and essential use of those devices this population has been characterized as an extremely sedentary.

This physical deconditioning causes or contributes to lifelong medical complications such as accelerated cardiovascular disease, diabetes, osteopenia, visceral obesity, immune system dysfunction, and accelerated aging (Nash, 2005). While the ''healthy'' population faces every day the risks for development of those chronic diseases, caused by a stressful lifestyle, nearly all risk factors anyway tend to be more prevalent in SCI subjects compared with ambulatory subjects (Myers et al., 2007). All epidemiological studies that have been conducted lately reported the emergence of cardiovascular disease (CVD) as a major cause of morbidity and mortality in persons with SCI (Jacobs & Nash, 2004).

The presence of SCI itself confers a higher risk of CVD because the body is confronted with huge physiological changes associated with SCI. These changes include impaired autonomic regulation that underlie abnormalities in resting heart rate, reduced heart rate variability, reduced contractility, increased plasma renin activity, and other autonomic irregularities.

There are also other secondary health problems such as deep vein thrombosis, urinary infections, pressure sores and back pain.

Daily energy expenditure is significantly lower in SCI individuals, not only because of a lack of motor function, but also because of the lack of accessibility and fewer opportunities to engage in physical activity.

Benefits of physical activity in SCI

Nowadays people are faced with different types of disabilities and accordingly different health implications. Regardless of the level and type of cord lesion, persons with SCI are among the most deconditioned of all humans (Jacobs & Nash, 2004).

Persons with SCI face unique health challenges throughout their lives, and their injuries dissociate the normally well integrated homoeostatic responses of body systems known to accompany physical activity. The damage of spinal cord disrupts the necessary signal conduction among motor, sensory and autonomic targets, and thus has a profound effect on fitness, exercise capacities and health. For instance, individuals with complete spinal cord injuries at or above the sixth thoracic level (T6) generally exhibit dramatically diminished cardiac acceleration with maximal heart rates less than 130 beats/min. That means at least that work capacity of these persons will be limited by reductions in cardiac output and circulation to the exercising musculature (Jacobs & Nash, 2004).

However, physical activity can play an important role in improvement of health status and in minimizing the incidence of development of the other chronic diseases which certainly follow SCI. A number of authors have reported beneficial effects from exercise and sports, and an overall improved level of fitness in people with SCI (Levins et al., 2004). Special adaptive equipment and, in some cases, the use of electrical current (either with or without computerized control) are commonly required in physical activity sessions. Inspite all limittations and potential risks of exercise that patient can meet, scientific evidence supports the belief that recreational and therapeutic exercise improves the physical and emotional well-being of participants with SCI.

Many of the metabolic and skeletal-muscle abnormalities associated with SCI can be partially reversed by different types of endurance training that involves upper-body arm ergometry, functional electrical-stimulation training of the lower limbs, or their combination (Myers et al., 2007).

Recommendations for physical activity

The spinal cord injury level has a direct impact on physical function and the cardiopulmonary and metabolic response to exercise. For this reasons exercise prescription recommendations and special considerations have to be taken into account.

When prescribing exercise testing and exercise activity for those with spinal cord injury, it is crucial to take into account the medical condition (spinal cord injury lesion level and level of completeness), personal and environmental factors.

The major components of a fitness program for people with disabilities would be the same as for the general population: cardiovascular endurance, strength, and flexibility.

General recommendations for strength training exercise prescription include resistance training using the free weights, weight machines and elastic bands. Resistance trainings should be conduct at least two times per week at light to moderate intensity which include three sets of 8 – 12 repetitions per exercise.

General recommendations for endurance training would be three to five exercise sessions per week with duration of 20 – 60 minutes per session. Intensity should be 50% – 60% VO2peak. The exercise includes arm cranking, swimming, arm propulsion, wheelchair sports, electrically simulated cycling and walking. The researchers suggest that target exercise intensities should be equivalent to 50 – 80 % of individual's peak heart rate. Overall, recommendations are general and they should be prescribed individually for each person with SCI from educated physical activity professional and medical stuff.

Training sessions for increasing flexibility should be performed two or three times per week up to 30 minutes per sessions, especially for reduction of shoulder pain which is the following consequence of wheelchair overuse.

In lane with prescribed physical activity nutritional needs for persons with SCI should be highly individualized because of wide differences in resting and daily energy expenditure. Routine consultation with a nutritionist may be helpful in the management of body weight and lipid profiles.

The risk of physical exercise and precautions

According to Nash (2005) while typical risks of exercise injury and overuse apply, the consequences of imprudent exercise in persons with SCI may be far more serious, potentially irreversible, and will likely compromise daily activities to a far greater extent than similar injuries arising in persons without SCI.

Special precautions must be taken when persons with SCI undertake exercise programs for physical conditioning. Special attention is required when designing, instituting or performing exercise programs for persons with SCI.

In special considerations the following potential states must be included: autonomic dysreflexia, hypotension and thermal instability, as well as musculoskeletal injury and skin inflammations. Those are the main reasons why physical activity for persons with SCI should be lead by well-educated physical activity professionals.

Barriers to exercise

Spinal cord injury is usually a huge traumatic experience for both, the injured person and person's life surroundings. It results in profound and long-term disability, and it is life changing. These injuries also have tremendous social costs associated with expensive health care treatment, rehabilitation, and lost productivity (Pickett et al.,2006).

People with SCI are faced with certain physical, social and psychological barriers all over the World, especially in non-developed and poor educated countries. The physical environment has traditionaly been viewed as an important but also modifiable barrier for people with mobility impairments (Scelza et al., 2007). Just some of them are architectural barriers that can be removed in order to make possible for persons with SCI to move more independently, to participate in daily life activities and to be socially more integrated.

In terms of interest for participation in physical activity, even if persons with SCI consider exercise to be an important aspect of their functional recovery (Anderson, 2004), and social integration as well, unique physical, physiological, psychological, and societal challenges, limit their ability to undertake exercise and fully benefit from physical conditioning.

Persons with this type of disability very rarely engage in physical activities for certain reasons: expensive equipment costs, funding, and knowledge of resources, unprofessional instructions and poor organization. Some of them reported that after their injury, they were faced with a great psychological deal of uncertainty as to their physical abilities and their opportunities for participation in physical activities (Levins et al., 2004). The others reported that their top concerns about exercise are the lack of motivation, lack of energy, cost of an exercise program and not knowing where to exercise (Scelza et al., 2005). On the other hand some others claim that everyday activities, lack of interest, lack of time and fatigue are the main reasons for not engaging in regular physical exercise and sports (Siosteen et al., 1990).

According to this, with the aim to support and enhance PA engagement of persons with SCI, the efforts primarily should be focused on: health promotion, accessibility and availability of fitness facilities, accessibility and availability of suitable exercise equipment, and physical activity professionals to advice and lead appropriate exercise program (Carpenter et al., 2007).

Health promotion

The primary aim of the health promotion programs among people with different types of disability should be: to reduce secondary consequences of disability (such as an obesity, metabolic syndrome, cardiovascular and cardiopulmonary chronic diseases, pressure sores); to support functional and mobility independence; to enhance the overall quality of life by reducing environmental barriers, and to provide an opportunity for leisure and enjoyment (Rimmer, 1999). In that sense big step has to be made from disease and disability prevention to the prevention of disease's secondary conditions and promotion of active lifestyle among disabilities.

PA professionals can play an important role in the integration of health promotion among people with disabilities. Accordingly PA professionals should be able to take the role of the leaders, as a professional collaborators, educators, researchers, and program providers (Teague, 1990).

However, PA promotion is very difficult in the absence of information regarding the PA characteristics such as types, amounts and intensities of activity that proceed fitness benefits. Those information are more than necessary in order to assist medical stuff and exercise programmers in prescribing and then promoting exercise and PA (Ginis et al., 2011). That also means that stronger relationship must be established between fitness and health care professionals. Taking all this into consideration, fitness centers are supposed to become the future centers of health promotion for people with disabilities.

CONCLUSION

Even if it's considered as one of the most severe types of disabilities, with a wide range of primary and secondary health consequences, as well as psychological and social issues, there is a huge opportunity to improve health condition of people with SCI, to maintain their active lifestyle and social integration by means of physical activity, exercise and sport. Many persons with SCI already benefit from a lifestyle that incorporates habitual physical activity. Despite special needs, equipment, risks, and preserved barriers to engage in PA, there is a strong evidence that prove reduction of multisystem disease in persons with SCI. It is proven that habitual exercise reduces fatigue, pain, weakness, musculoskeletal decline, and neurological deficits that accompany aging with disability.

Exercise management has to be on the highest level to ensure that physical activity and daily activities can be sustained without interruption and complications. If it's carefully prescribed, physical exercise has the power to improve life satisfaction, to empower positive psychosocial aspects of life and to enhance health state of persons with SCI.

To sum up, the main aim of all health care and PA professionals should be to encourage persons with SCI to continue their use of therapeutic and to adopt at least recreational type of exercise as a health-enhancing strategy after SCI.

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EFFECTS OF EXERCISE ON SUBCUTANEOUS ADIPOSE TISSUE AND BODY COMPOSITION OF FEMALE STUDENTS

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SUMMARY

The aim of this study was to determine the effects of the 12-week aerobic dance training program on the parameters of body composition among female students. A total of 25 female students participated in this study, of which 19 completed the experimental program. The average age of subjects was 22.58 ± 1.68 years. Subcutaneous adipose tissue was evaluated by the sum of 5 skinfold (subscapular, abdomen , triceps, thigh and calf). Bioelectric impedance analysis (BIA) was performed for the assessment of body composition. The results showed that total fat tissue has significantly reduced after the 12-week training program with very large effect size (ES=0.82). The moderate improvement in the parameters of body composition was gain in fat-free mass (ES = 0.50). Highest number of observed variables has achieved small ES, ranged from 0.26 in muscle mass to 0.49 in body fat. Aerobic dance training program did not achieve effects in fat-free mass index (ES = 0.03). This study confirmed that the parameters of body composition will undergo changes after a 12-week of aerobics dance training program. The biggest changes were found in the total amount of subcutaneous fat and increase in fat-free mass.

Keywords: Exercise, aerobic, female students, body composition, effect.

INTRODUCTION

In practice, there is a numerous exercise programs aimed to improve health status, reduce body weight, improve cardiorespiratory fitness and etc. The choice of program depends primarily on the motives and needs of the individuals. In women, the motive for the exercise is commonly associated with the motive of health, but also a motive for improving their appearance and in the end a motive for the reduction of body weight (Stojiljković, 1996).

The most commonly practiced exercise training programs for women are different kind of group fitness programs. The aim of these programs is to answer the motives for preserving health, improving physical appearance and weight reduction (Mandarić, 2005). These exercise programs are based on the principles of aerobic exercise of Kenneth Cooper. Group fitness programs are programs whose main characteristic is exercise in a group, with music. Their diversity is reflected in the nature of the movement structures that are used within the program, biomechanical parameters, purpose and use of devices and equipment (Mandarić, 2011). Among fitness programs, programs of aerobic dance have very important place. The main goal of aerobic exercise is to develop cardiorespiratory fitness (with different moving structures - walking, running, etc.). However, in addition to the above there are other goals of aerobic exercise. Obradović (1999) stated in his research the following goals of aerobic exercise: motor - functional; health; aesthetic and socio - psychological goals.

The current available research has confirmed that it is possible to meet the stated goals of aerobic exercise (Schmidt, Biwer, & Kalscheuer, 2001). Aerobic exercise, in addition to improvements in cardiorespiratory fitness, can be used for the preservation and improvement of other fitness components, increasing strength and improving flexibility (Grant, Todd, Aitchison, Kelly, & Stoddart, 2004; Okura, Nakata, & Tanaka, 2012). The aim of this study was to determine the effects of the 12-week aerobic dance training program on the parameters of body composition among female students.

METHODS

Subjects

A total of 25 female students participated in this study, of which 19 completed the experimental program. The average age of subjects was 22.58 ± 1.68 years. The criteria for selecting participants were: they were not included in some form of organized physical exercise for the last 6 months, that in addition to the experimental program did not participate in other forms of programmed physical exercise, that they exercise regularly (three times a week), and do not have acute or chronic diseases. Before joining the program, each participant gave written consent on voluntary participation.

Procedure

Anthropometry method was applied to determine the physical characteristics (Đurašković, 2002). Anthropometric variables were measured according to the guidelines of the International Biological Program (IBP) (Weiner & Lourie, 1968). Body weight and height were measured to determine the Body Mass Index (BMI). BMI is calculated using the formula proposed by the World Health Organization (WHO, 1997; ACSM, 2006). Subcutaneous adipose tissue was evaluated by the sum of 5 skinfold (subscapular, abdomen , triceps, thigh and calf). Bioelectric impedance analysis (BIA) was performed for the assessment of body composition using the TANITA UM - 72 (Body Composition Monitor Tanita Corp. , Tokyo , Japan) . The following parameters were evaluated: Body fat (%), Body fat (kg), Muscle Mass (%), Muscle Mass (kg). Fat Free Mass (%), Fat mass index (FMI - kg/m2) and Fat-free mass index (FFMI - kg/m2) were calculated according to the equations of James (1976), Peltz et al., (2010) i VanItallie et al. (1990).

Exercise programm

Exercise program lasted 12 weeks, with a frequency of three times a week. Each workout lasted 60 minutes. The experimental program consisted of aerobic dance. Aerobic program was based on three parts: initial part (warming up, pre-stretching), the main part (aerobic part and body shaping) and the final part (cooling down, deep stretching, relaxing) (Zagorc i sar., 1998, 62). When summarized, the initial part and the final part lasted 15-20 minutes, whereas the main part took 40-45 minutes.

Statistical analysis

Collected data have been analyzed in statistical program SPSS 17.0 (SPSS Inc., Chicago, IL). Each variable is represented by mean value and standard deviation (mean ± SD). Cohen Effect size was used to determine the actual size of the effect of the patients after the implemented program. The criteria for determining the size of the impact was determined on the basis of Cohen (1988), Cohen (1992) and Hattie (2009) (<0.20 has no effect ; 0.20 to 0.50 small ; 0.50-0.80 moderate ; > 0.80 large).

RESULTS

The research results are presented in tables and graphs. Table 1 shows the results of the basic descriptive parameters on the initial and final measurements, as well as the percentage difference between the two measurements. The results showed that total fat tissue has significantly reduced after the 12-week training program (Figure 1) with very large effect size (ES=0.82). The moderate improvement in the parameters of body composition was gain in fat-free mass (ES = 0.50; Figure 7). Highest number of observed variables has achieved small ES, ranged from 0.26 in muscle mass to 0.49 in body fat. Aerobic dance training program did not achieve effects in fat-free mass index (ES = 0.03).

Table 1. Basic descriptive parameters at the initial and final measurement (n=19)

Variables	Initial Mean±SD	Final Mean±SD	% difference
Body height [cm]	165.18±6.73	-	-
Body weight [kg]	62.97±5.94	60.55±5.38	-3.84%
SF subscapula [mm]	13.02±4.73	11.85±4.37	-8.99%
SF abdomen [mm]	15.99±5.79	13.19±4.46	-17.51%
SF triceps [mm]	22.41±6.10	19.17±4.04	-14.46%
SF thigh [mm]	20.08±5.06	16.92±4.06	-15.74%
SF calf [mm]	11.56±3.91	10.40±3.11	-10.03%

Legend: SF – skin fold; ΣSF – overall sum of skinfolds; FMI - Fat Mass Index; FFMI - Fat-free Mass Index

Table 2. Basic descriptive parameters and percentage differences between initial and final measurement

Variables	Initial Mean±SD	Final Mean±SD	% difference
ΣSF [mm]	83.12±15.66	71.53±12.39	-16.20%
BMI [kg/m^2]	23.12±2.32	22.28±2.22	-3.77%
Body Fat [%]	23.03±4.39	20.83±4.55	-10.56%
Body Fat [kg]	13.67±4.66	12.39±4.55	-10.33%
Muscle Mass [%]	30.97±4.06	32.00±3.67	3.22%
Muscle Mass [kg]	19.31±2.22	19.47±2.93	0.82%
Fat Free Mass [%]	76.97±4.39	79.17±4.55	2.78%
FMI [kg/m^2]	7.65±1.70	7.04±1.62	-8.66%
FFMI [kg/m^2]	16.42±0.81	16.45±0.82	0.18%

Legend: SF – skin fold; ΣSF – overall sum of skinfolds; FMI - Fat Mass Index; FFMI - Fat-free Mass Index

Figure 1. Differences in skin folds

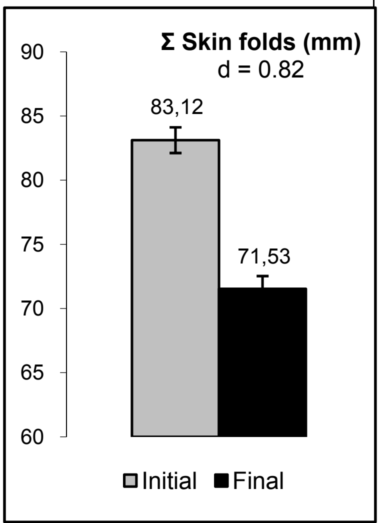


Figure 2. Differences in BMI

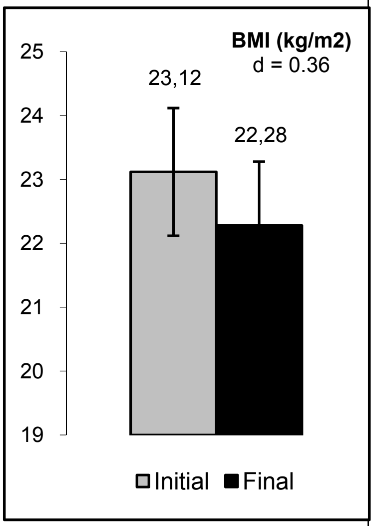


Figure 3. Differences in body fat (%)

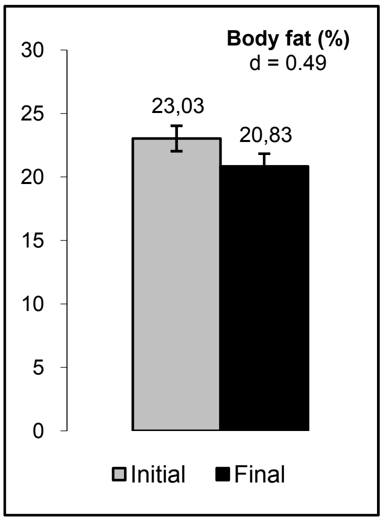


Figure 4. Differences in body fat (kg)

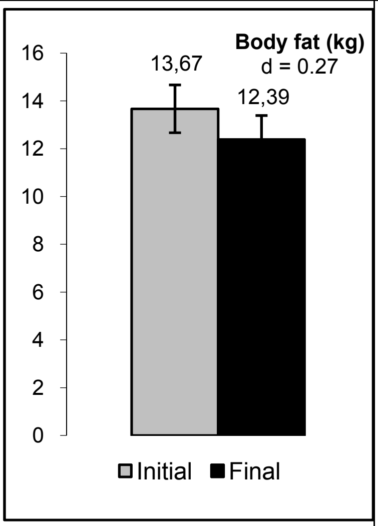


Figure 5. Differences in muscle mass (%)

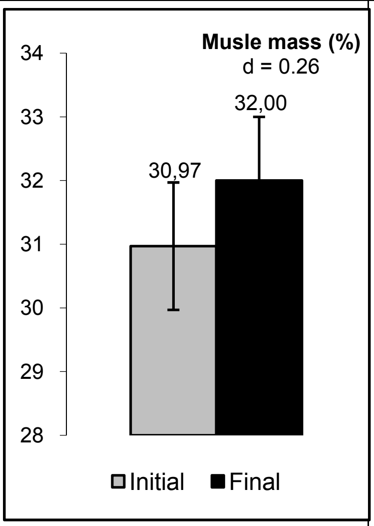


Figure 6. Differences in muscle mass (kg)

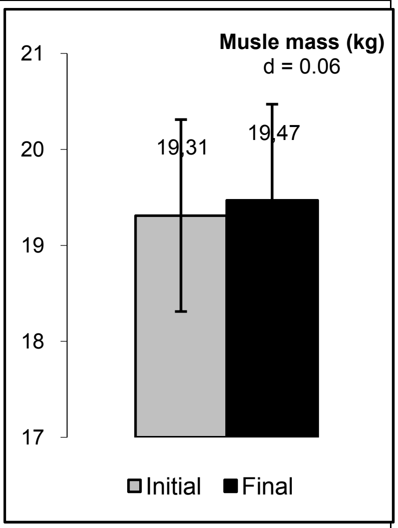
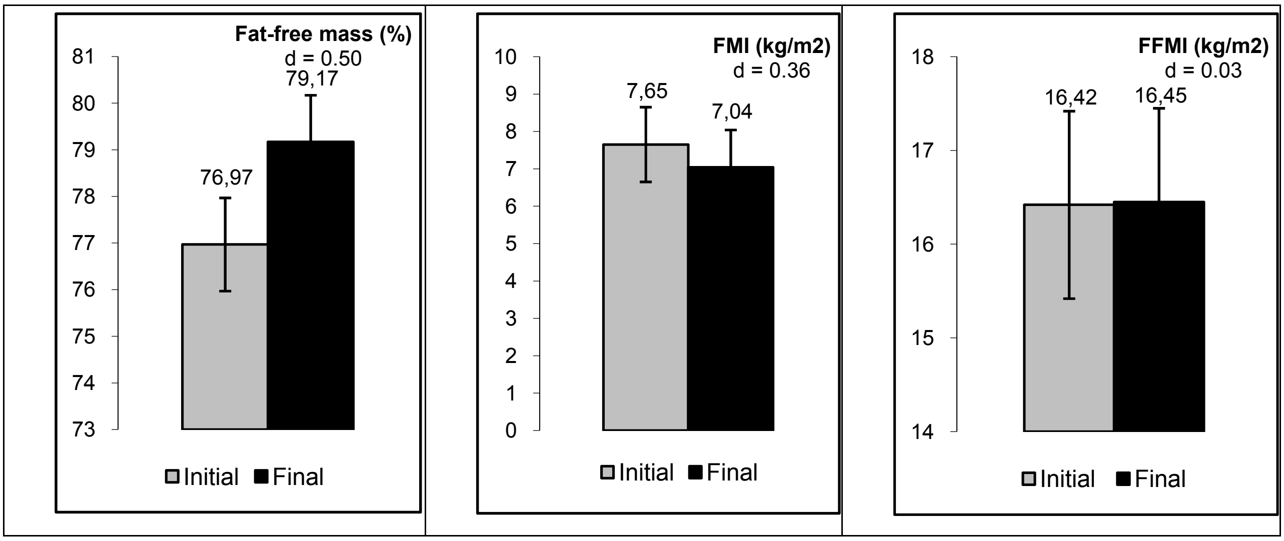


Figure 7. Differences in fat free mass (%)

Figure 8. Differences in FMI

Figure 9. Differences in FFMI



DISCUSSION

This research supports the assumption that aerobic dance represents adequate training activity to improve the parameters of body composition and reduction of subcutaneous fat. The impact was greatest in the subcutaneous tissue and the total reduction in the relative values of body fat . Also , this training program is adequate for the increase in fat- free mass , which is essential for normal daily activities. Burgess, Grogan, and Burwitz (2006) have also confirmed that aerobic dance leads not only to improved body composition but also affects the body image and physical self-perceptions in girls.

Our results are consistent with previous studies that also confirm that aerobic dance is an adequate physical activity that can cause changes even when training programs are shorter than 12 weeks (Gubiani & Neto, 1999). Above mentioned changes are due to the structure of the lesson of aerobic dance that is mostly aerobic type of activity where fat plays dominant role in energy production (Pantelić, Milanović, Sporiš, Stojanović-Tošić, & Novak, 2013). Pantelić et al. (2013) found that aerobic dance causes similar changes in total subcutaneous adipose tissue in the lower and upper extremities which clearly shows that all structures of the body are equally engaged.

Beside the reduction of subcutaneous adipose tissue, aerobic dance training has led to an increase in fat- free mass to 2.78 %, which shows that this training program is working simultaneously on multiple fitness components. At the same time the effect of a specific program on multiple fitness components is necessary because the aging process leads to a decrease of helath - relate physical fitness components (Milanovic et al., 2013). Recommendations (ACSM, 2013) point to the necessity of a complete fitness status at a high level in order to act preventively to the numerous cardiovascular and respiratory diseases caused by low levels of physical fitness.

Undoubtedly, this study showed that exercising aerobic dance can lead to a multiple benefits in reducing body fat, increasing lean body mass on both of the absolute and the relative level. Nevertheless, the limitation of this study represents a small number of variables associated with other components of health-related physical fitness such as cardiorespiratory fitness, muscle fitness and flexibility. Future studies should investigate the effects of aerobic dance on other parameters of physical fitness.

CONCLUSION

This study confirmed that the parameters of body composition will undergo changes after a 12-week of aerobics dance training program. The biggest changes were found in the total amount of subcutaneous fat and increase in fat-free mass. In contrast FFMI showed trivial changes after the training program.

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STUDENTS' ATTITUDES TOWARDS PRACTICAL TEACHING WITHIN SUMMER OUTDOOR ACTIVITIES – CAMPING

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SUMMARY

The research was conducted on a sample of 213 male and female third year students of the Faculty of Sport and Physical Education in Novi Sad, of which 42 were female-students and 171 were male-students, who participated in practical teaching of camping held at Begečka Jama in June 2014. Five-point Likert scale of attitudes prepared specifically for this research was used as a measuring instrument. Statistical method used for data processing between the initial and final measurement was the Wilcoxon test. Analysis of the data led to the conclusion that students rated teaching within summer outdoor activities as highly positive.

Keywords: camping, attitudes, teaching.

INTRODUCTION

In terms of different samples from the population of students, determining attitudes is often used method and it often determines the quality of existing curricula, the adequacy of different teaching methods, quality of accommodation, quality of education rooms, nutrition... Various conditions in the population of students of the faculties of sport and physical education of the universities of Belgrade, Novi Sad, Niš, or Leposavić can be noted through their attitudes. However, in practice not many research dealt with attitudes of students of the faculties of sport and physical education towards summer outdoor activities-camping as very interesting motor activity of humans.

In a sample of 191 students (Radosav, Krsmanović and Cvetković 2008) of the Faculty of Sport and Physical Education, University of Novi Sad, of different sexes, who attended the course in Outdoor Activities during the school year 2000/2001 (62 male and female students), 2001/2002 (44 male and female students) and 2002/2003 (85 male and female students), Likert scale was applied for assessment of attitudes on conditions, contents, organization and operationalization of teaching of Outdoor Activities – Camping. The results obtained suggest a positive attitude of students towards the content of teaching and according to the authors the students also helped in conceptualization of teaching.

In a sample of 52 respondents (male and female), students of the Faculty of Physical Education and Sport in Pale, who participated in practical teaching of Outdoor Activities in July, school year 2007/08, the authors (Stojanović, Savić and Miletić 2010) used a standardized questionnaire in the form of a five-point Likert scale and came to the results showing students rated training in the subject of Outdoor Activities – Camping, as highly positive and high-quality.

Also, in Savić, Milojević and Miletić (2006), Savić and Miletić (2008) and Stojanović, Savić, Miletić and Vukić (2009), studies similar to present, the authors studied students' attitudes on conditions, contents and organization and operationalization of teaching of Outdoor Activities. Analysis of the results showed that students have a positive attitude towards the curriculum of the course in Outdoor Activities and its implementation.

In their research of students' attitudes on summer outdoor activities, very positive assessments by the respondents were observed.

Overall, the students, in research so far known to the author, showed positive attitudes towards the summer outdoor activities that included camping.

The subject of this study is the status of module of practical teaching in Summer Outdoor Activities – Camping at the Faculty of Sport and Physical Education in Novi Sad, as well as students' attitudes toward expectations from realization of teaching and attitudes towards the level of satisfaction of their expectations. The paper focuses on students' attitudes towards teaching within the framework of the Summer Outdoor Activities. The aim of this study was to determine the attitudes of students of the Faculty of Sport and Physical Education, University of Novi Sad, on their expectations from camping training, their views on the level of satisfaction of expectations, as well as to compare the attitudes of different groups of students.

METHODS

Subjects

The sample consisted of 213 male and female third year students of the Faculty of Sport and Physical Education in Novi Sad, of which 42 were female-students, and 171 were male-students.

Procedure

Likert five-point scale of attitudes prepared by the author for this specific research was used as a measuring instrument. Sample questionnaire is attached (Table 1) and is as follows:

Mode of Study (underline): state-funded–self-funded studies Sex (underline): male-female.

Put mark **X** in the boxes that correspond to **your attitude** towards the implementation of practical training of summer Outdoor Activities - Camping.

Table 1 Likert five-point scale of attitudes – Queastionnaire

	I strongly **disagree**	I partially **dissagree**	No attitude	I partially **agree**	I strongly **agree**
1. I like the summer outdoor activities in their entirety.					
2. The content of the teaching within summer Outdoor Activities was interesting to me.					
3. The knowledge that I acquired during teaching will be useful to me in my future life.					
4. Teachers who conducted the classes were interesting and they communicated the knowledge well.					
5. I like the teaching location.					
6. Intensive teaching during one night and two days is sufficient for teaching realization.					
7. I would change the content of practical teaching of summer outdoor activities					
8. When I graduate and get a job at school I will take my students to summer outdoor activities.					
9. If I had the right as a student, I would attend teaching of summer outdoor activities again.					
10. Summer outdoor activities do not interest me, it is important for me just to get a signature.					

After defining the research subject, instrument and respondents were prepared for the implementation of collecting information on the students' attitudes by using the survey as research technique. The instrument – the questionnaire is compiled based on the authors' experiences and wish to collect the necessary information for reaching a conclusion on the students' attitudes. The students who opted for camping as the content within the course of Summer Outdoor Activities were "available" to the authors. The respondents – students were adequately prepared (acquainted with the idea, their possible tasks, using information obtained...) and they have voluntarily accepted the role of respondents in the research and as such well collaborated with the authors in the realization of information collection.

Information collection was conducted in two phases: after arriving to the camping location at Begečka Jama, immediately upon arrival and the last day of camping after completion of all lectures and attending all the exercises. The survey period was the month of June, 2014.

Statistical analysis

The paper used nonparametric methods for data processing. Frequencies, percentages of attitudes in each variable separately, as well as data on distribution asymmetry (Skewness) and distribution peakedness (Kurtosis) are displayed in order to obtain information about the students' positive attitudes in general, and between genders toward the summer outdoor activities – camping. By applying the Wilcoxon test, differences among the respondents as a whole were tested, as well as in male and female subjects between the initial and final measuring at the level of statistical significance of p≤0.05. Data analysis was performed by using the statistical package "SPSS 20.0".

RESULTS

A total of 22 variables were analyzed of which 11 variables were from the initial measurement (A1, A2, A3, A4, A5, A6, A7, A8, A9, A10 and SurveyA), while the remaining 11 were variables from the final measurement (B1, B2, B3, B4, B5, B6, B7, B8, B9, B10 and SurveyB). Variables SurveyA and SurveyB are composite indicators, i.e. the sums of responses to all items of the given questionnaire. All of these variables represented attitudes of the students of the Faculty of Sport and Physical Education before and after the summer outdoor activities – camping at Begečka Jama.

Kurtosis and skewness were also used as confirmation of students' orientation toward one or another level of agreeing with the stated attitude. These also point to the fact that the list of attitudes is not standardized, but was made up for this research. Given that these are the data that are arranged in ascending or descending intensity, without measurement intervality and without real zero (ordinal scale), the frequencies of occurrence of the level of agreeing with the above findings and their percentage distribution are included in the analysis of the research results.

After analyzing the data on students' attitudes, i.e. levels of orientation of given statements, the following results were obtained.

Table 2 Students' attitudes toward Summer Outdoor Activities

Variable	1		2		3		4		5	
	f	%	f	%	f	%	f	%	f	%
B1	12	5.6	10	4.7	11	5.2	96	45.1	84	39.4
B2	10	4.7	15	7.0	16	7.5	71	33.3	101	47.4
B3	9	4.2	8	3.8	13	6.1	78	36.6	105	49.3
B4	5	2.3	11	5.2	16	7.5	58	27.2	123	57.7
B5	18	8.5	20	9.4	23	10.8	84	39.4	68	31.9
B6	23	10.8	36	16.9	25	11.7	58	27.2	70	32.9
B7	29	13.6	22	10.3	40	18.8	49	23.0	73	34.3
B8	12	5.6	10	4.7	57	26.8	61	28.6	73	34.3
B9#	130	61.0	29	13.6	22	10.3	20	9.4	12	5.6
B10	24	11.3	11	5.2	34	16.0	64	30.0	80	37.6

Legend: # – Inverse variable; f – frequency of results; % – percentage distribution of results

Table 2 shows data on the frequency of results as well as their percentage distribution for each variable from the final measurement. Regarding the male respondents' attitudes (Table 3), we find that the attitudes toward given statements in all variables are positive.

Table 3 Male students' attitudes toward Summer Outdoor Activities

Variable	1		2		3		4		5	
	f	%	f	%	f	%	f	%	f	%
B1	9	5.3	8	4.7	11	6.4	78	45.6	65	38.0
B2	10	5.8	12	7.0	15	8.8	57	33.3	77	45.0
B3	9	5.3	7	4.1	12	7.0	63	36.8	80	46.8
B4	4	2.3	11	6.4	13	7.6	47	27.5	96	56.1
B5	16	9.4	16	9.4	21	12.3	67	39.2	51	29.8
B6	21	12.3	26	15.2	21	12.3	48	28.1	54	31.6
B7	24	14.0	15	8.8	34	19.9	37	21.6	61	35.7
B8	12	7.0	7	4.1	53	31.0	45	26.3	54	31.6
B9#	101	59.1	21	12.3	21	12.3	16	9.4	12	7.0
B10	20	11.7	10	5.8	29	17.0	51	29.8	61	35.7

Legend: # – Inverse variable

Table 4 Female students' attitudes toward Summer Outdoor Activities

Variable	1		2		3		4		5	
	f	%	f	%	f	%	f	%	f	%
B1	3	7.1	2	4.8	0	0	18	42.9	19	45.2
B2	3	7.1	0	0	1	2.4	14	33.3	24	57.1
B3	0	0	1	2.4	1	2.4	15	35.7	25	59.5
B4	1	2.4	0	0	3	7.1	11	26.2	27	64.3
B5	2	4.8	4	9.5	2	4.8	17	40.5	17	40.5
B6	2	4.8	10	23.8	4	9.5	10	23.8	16	38.1
B7	5	11.9	7	16.7	6	14.3	12	28.6	12	28.6
B8	0	0	3	7.1	4	9.5	16	38.1	19	45.2
B9#	29	69.0	8	19.0	1	2.4	4	9.5	0	0
B10	4	9.5	1	2.4	5	11.9	13	31.0	19	45.2

Legend: # – Inverse variable

Table 5 Distribution of the results of attitudes after realization of Summer Outdoor Activities

Variables	S	K	MIN	MAX
B1	-1.522	1.969	1	5
B2	-1.364	1.123	1	5
B3	-1.666	2.578	1	5
B4	-1.631	2.213	1	5
B5	-0.959	-0.051	1	5
B6	-0.540	-1.045	1	5
B7	-0.569	-0.950	1	5
B8	-0.774	0.023	1	5
B9#	1.264	0.287	1	5
B10	-0.939	-0.192	1	5

Legend: # – Inverse variable; S – Skewness value; K – Kurtosis value; MIN – minimum; MAX - maximum;

The review of Table 4 and analysis of female students' attitudes toward summer outdoor activities show us very positive attitude towards the given statements.

The review of Table 5 containing the data on distribution asymmetry and peakedness, we can see that in the variables B1, B2, B3, B4, and B9# there is an extreme asymmetry of the results towards the zone of higher values indicating the fact of positive and more confident orientation of students toward most of the attitudes.

Kurtosis values are positive in the most variables (B1, B2, B3, B4, B8 and B9#), which means that students' attitudes are generally homogeneous.

Table 6 shows the differences in the attitudes of students of the Faculty of Sport and Physical Education at the initial and final measurement.

Table 7 shows the differences in the attitudes of students of the Faculty of Sport and Physical Education at the initial and final measurements, for male participants and Table 8 for female participants.

Table 6 Differences in attitudes of students of the Faculty of Sport and Physical Education at the initial and final measurement

Variables	N	MR	SR	Z	p
SurveyB - SurveyA	68[a]	86.79	5902.00	-3.898	0.000
	119[b]	98.12	11676.00		
	20[c]				

Legend: [a] – Negative rankings; [b] – Positive rankings; [c] – Balanced rankings; N – number of respondents; MR – Medium ranking; SR – Sum of rankings; Z – Wilcoxon test value; p – statistical significance

Table 7 Differences in male students towards Summer Outdoor Activities

Variables	N	MR	SR	Z	p
SurveyB – SurveyA	59[a]	72.27	4264.00	-2.965	0.003
	94[b]	79.97	7517.00		
	15[c]				

Legend: [a] – Negative rankings; [b] – Positive rankings; [c] – Balanced rankings; N – number of respondents; MR – Medium ranking; SR – Sum of rankings; Z – test value; p – statistical significance

Table 8. Differences in female students towards Summer Outdoor Activities

Variables	N	MR	SR	Z	p
SurveyB – SurveyA	9[a]	15.22	137.00	-2.746	0.006
	25[b]	18.32	458.00		
	5[c]				

Legend: [a] – Negative rankings; [b] – Positive rankings; [c] – Balanced rankings; N – number of respondents; MR – Medium ranking; SR – Sum of rankings; Z – test value; p – statistical significance

DISCUSSION

Analysis of the results in Table 2 individually speaking, showed that in the variable B1 96 (45.1%) respondents had a positive response to whether they liked summer outdoor activities in their entirety, with score of 4 (I partially agree with the statement), while 84 (39.4%) respondents strongly agree with the statement (score 5). Regarding the variable B2, asking whether teaching at summer outdoor activities was interesting, 101 (47.4%) respondents gave the highest score (I strongly agree with the statement), while 71 (33.3%) respondents gave score 4 (I partially agree with the statement). By reviewing the results for the variable B3, analysis of the results shows us that 105 (49.3%) respondents strongly agree with the statement that knowledge acquired during teaching will be useful to them in the future life. Regarding the variable B4, 123 respondents (57.7%) strongly agree with the statement that their teachers were interesting and that they communicated knowledge well, while 58 respondents (27.2%) partially agree with this statement. The analysis of the variable B5, stating "I like the teaching location", 84 (39.4%) respondents partially agree with the statement, while 68 respondents (31.9%) strongly agree with this statement. 32.9% of the respondents strongly agree, while 27.2% of the respondents partially agree with the statement that the intensive teaching during two nights and three days is sufficient for teaching realization.

Regarding the statement that teaching of more than two nights and three days spent outdoor would be realized better and more interesting for the students, 34.3% and 23.0% of the students strongly and partially agree with the statement, respectively, while 18.8% of the students have no attitude. Regarding variable B8, 34.3% of the students strongly agree with the statement, while 28.6% of the students partially agree with the statement. However, the same number of students has no clear stance on this statement (28.6%). Regarding the results in variable B9# "Summer outdoor activities do not interest me, it is important for me just to get a signature", 130 (61.0%) respondents strongly disagree with the statement, 29 (13.6%) respondents partially disagreed with the statement. In 10th variable B10, we can see that 80 students or 37.6% strongly agree with this statement, while 64 students or 30.0% partially agree with this statement.

By analyzing Table 3 regarding the variable B1 45.6% of the respondents partially agree with this statement. By examining the variables B2, B3 and B4 we can see that the largest percentage of respondents falls under statements 4 and 5. In variables B5, B6 and B7 also a large part of the respondents belong to the ranks of positive attitudes (strongly agree and partially agree with the statement). If we review statements in variable B8 we can see that 54 respondents strongly agree with the statement, however, 53 respondents had no defined attitude. In the variable B9# 59.1% of the students strongly disagree with the statement that they are not interested in the summer activities and that signature is what is important to them, which can be brought in connection with teaching content realized on camping. Analysis of the last variable B10 shows that the highest percentage of males (35.7% and 29.8%) had a positive attitude towards the statement "If I had the right as a student, I would attend teaching of summer outdoor activities again".

In Table 4 we can see that in the variable B1 scores 4 and 5 are given by 42.9% and 45.2% of the female respondents, 4.8% and 7.1% gave scores 2 and 1, while no one gave score 3 (no attitude toward the statement).

By examining the variables B2 and B3 we note that the highest level of agreeing was 57.1% and

59.5%, which speaks in favor of teaching contents realized on summer outdoor activities. In variables B4# and B9 we can also note very positive attitudes towards those statements. In both variables over 60.0% of the female respondents fully agree with the statement.

40.5% of the female respondents partially and strongly agree with the statement that they like the teaching location (B5). Regarding B6, intensive teaching of one night and two days is sufficient for teaching, 38.1% of the female respondents strongly agree with the statement while 23.8% of the female respondents partially agree with the statement. The same number (23.8%) of the female respondents partially disagree with the statement. 12 (28.6%) female respondents in the variable B7 share the attitude that the teaching of more than two nights and three days outdoor would be better and more interesting for students. By examining the variables B8 and B10 we can conclude that in 45.2% in both variables the female respondents strongly agree with the above statement.

By reviewing the Table 5 containing the data on distribution asymmetry and peakedness, we can see that in the variables B1, B2, B3, B4, and B9# there is an extreme asymmetry of the results towards the zone of higher values indicating the fact of positive and more confident orientation of students towards to most statements. Kurtosis values are positive in the most variables (B1, B2, B3, B4, B8 and B9#), which means that students' attitudes are generally homogeneous.

In order to determine whether the teaching content led to a change in the attitudes of students of the Faculty of Sport and Physical Education toward summer outdoor activities, as well as whether there are statistically significant differences between sexes of respondents regarding attitudes towards summer outdoor activities, we applied the Wilcoxon test (Wilcoxon Signed Rank test) for testing and determining statistically significant differences between initial and final measurements (see Table 6). Summation scores were used to obtain the differences between attitudes in their entirety on the initial and attitudes in their entirety on the final measurement (Survey A and Survey B) that are shown in the first column. The second column shows the number of respondents, the third column shows the middle ranking, the fourth column contains the sums of rankings and at the end there is the test value – Z, and statistical significance – p. The level of statistical significance was 0.05.

Based on the results shown in Table 6 and the level of statistical significance (p = 0.000), we can conclude that there is a statistically significant difference between the initial and final measurements in the attitudes of the students of the Faculty of Sport and Physical Education toward the summer outdoor activities. By reviewing the column with the number of participants, as well as the column containing the sum of rankings we can notice that the results obtained are in favor of the final measurement, because 119 respondents is above the middle ranking (98.12).

By analyzing Table 7, where we tested the significance of differences in attitudes in relation to male respondents, we note that the number of respondents who are above middle ranking is higher (94) than the number of respondents who are below middle ranking (59). The sum of positive rankings is 7517.00 which is higher than the sum of negative rankings which equals to 4264.00, and we can conclude that the results are prevalent in favor of the final measurement. The value of p is 0.003 which is less than the critical value of 0.05 and we can conclude that there is a statistically significant difference between the initial and final measurement.

Regarding differences in female respondents' attitudes toward the summer outdoor activities (Table 8), we can also determine that there is significant difference between the respondents with positive rankings (25) and the respondents with negative rankings (9). By analyzing the last column that contains data on statistically significant differences, we can establish that there is also a statistically significant difference in female respondents between the initial and final measurement (p=0.006).

The sum of positive ranks is 458.00 while the sum of negative rankings is 137.00 so we can establish that the differences are in favor of the final measurement.

CONCLUSION

Determining the students' attitudes toward different facilities and in different areas has been frequently applied method, especially in the fields of psychology, pedagogy, medicine, and even in the area of physical education. Overall, the students, in studies so far known to the authors, have shown a positive attitude towards the Summer Outdoor Activities – Camping.

The research results obtained based on the frequency and percentage representation of results, as well as using skewness and kurtosis values, indicate a majority of positive attitudes towards statements related to the course in Summer Outdoor Activities and on the basis of these results, we can conclude the following:

- the majority of surveyed male and female students in the final survey had a positive attitude towards the teaching of camping.

- the majority of male students showed a positive attitude towards the teaching of camping in the final survey.
- the majority of female students showed a positive attitude towards the teaching of camping in the final survey.

By analyzing Table 4, Table 5 and Table 6 that contain details on whether there is a statistically significant difference between initial and final measurements, and based on the results obtained, we can conclude the following:

There was a statistically significant difference in attitudes obtained in the survey before and after the realized classes of summer outdoor activities – camping.

Skepticism in relation to the conclusions on the basis of the results obtained is legitimate because the levels of researcher's experience, the quality of the sample, applied methods, non-standardized measuring device, have their influence to these results, so the need for verification of the results for future research is justified.

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STUDENTS' ATTITUDES TOWARDS PRACTICAL TEACHING WITHIN WINTER OUTDOOR ACTIVITIES - SKIING

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SUMMARY

The research was conducted on a sample of a total of 78 male and female third year students of the Faculty of Sport and Physical Education in Novi Sad, of which 28 were female-students and 50 were male-students who participated in practical teaching of skiing within the course in Winter Outdoor Activities on Kopaonik in February 2013. Five-point Likert scale of attitudes prepared specifically for this research was used as a measuring instrument. In order to describe the sample of respondents the frequency of occurrence of information on the characteristics of the sample of respondents was determined based on the previous stay on the mountain in winter conditions as well as the possible attendance of ski school before the realization of the teaching of skiing with the faculty. Then, the descriptive indicators and frequency of occurrence and percentage rates of the attitudes for the total sample were determined prior to the realization of teaching of skiing, and then the same was performed on the sample after realization of teaching. After the division of participants into groups according to their level of skiing technique (average scores were derived from scores 1 and 2) basic descriptive indicators of the level of success for both scores were determined. Finally, the chi-square test values and the value of statistical significance of differences were calculated for variables (attitudes) after the realization implementation of teaching of skiing. The research results indicate a majority of positive attitudes towards expectations from teaching of skiing.

Keywords: skiing, attitudes, teaching.

INTRODUCTION

Ensuring the highest academic standards is the responsibility of higher education institutions. Faculty of Sport and Physical Education, University of Novi Sad, was established in order to achieve the mandated and accepted role in society through its graduates, competitive in the labor market. The curriculum of undergraduate academic studies at the Faculty of Sport and Physical Education (FSPE) in Novi Sad has been created in accordance with the provisions of the Law on Higher Education. This curriculum is being implemented during the four-year-term, after which it is possible to enter a master studies at the FSPE.

Skiing, as part of the Winter Outdoor Activities course, is attended at third year – the seventh semester and is designed as an elective course, considering that within the specified course the students can choose between the skiing and skating. The curriculum, mostly related to the practical part (and partly to the theoretical contents), is realized in mountain conditions and within a period of 7 days. Practical teaching is realized at the mountain of Kopaonik.

Skiing as a course, or part of the course of Winter Outdoor Activities, exists at other faculties also, both in Serbia and in other countries. Skiing as motor activity, but also educational and scientific field, is represented, in addition to the related higher education institutions (faculties of sport and physical education,...) also at the other educational institutions, where competences in terms of skiing knowledge and skills are very important for output profiles of graduates, (Army Military Academy, Police Academy...). Within the curricula of various higher education institutions, skiing as teaching content, is not equally treated and depends on the vision of each of these institutions. At the FSPE in Novi Sad we recognized the importance of the knowledge and skills of skiing as specific competence of graduate student and they are provided within the curriculum of the course of Winter Outdoor Activities. Specific competencies, expressed through the existing knowledge and skills in the area of skiing, are not decisive in the evaluation of FSPE graduates and their competitiveness in the market, but at the same time are extremely important for the complete realization of that very profile of a graduate student.

Skiing is a specific motor activity expressed through mastering slopes covered with snow using special equipment for that activity (skis, boots, poles...). Skiing belongs to the family of Olympic sports. Ski disciplines are divided into alpine, Nordic and ski jumping – flights. Although there are variations of relay races in Nordic skiing (and also attempts to popularize the teams participation in the alpine disciplines) skiing is mostly an individual sport. The ski sports also include snowboarding, which was also included as an Olympic sport since 1998. Alpine ski disciplines that are the subject of this work, unofficially could be categorized as technical (slalom and giant slalom) and speed (downhill and Super-G). All rules related to the organization and control of skiing events are defined (or are in the process of defining, or subject to modification) by the International Ski Federation (FIS) with its headquarters in Bern (Switzerland).

Attitude, as a subject of interest of this paper, is defined as acquired, relatively permanent and stable organization of positive or negative emotions, evaluating and responding to an object. Attitude structure consists of three components: cognitive, which refers to knowledge about the object of an attitude, emotional, referring to emotional experience of the object of an attitude, and conative, which relates to actions toward the object of an attitude. Although attitudes include willingness for certain behavior and have a great impact on behavior, prediction of behavior based on attitudes is not easy.

Because recreational skiers mostly do not prepare for skiing, injury risk factors increase (Mitić, 1994). Generally, research on the population of students showed that, on average, most students (86.34%), expressed positive attitude towards analyzed elements of teaching, but also that individual elements can be improved (by rotation of group leaders, physical preparedness for training, clearer definition of the exams criteria...), and that the difference was observed in the attitudes of students between the first and second course of practical teaching of skiing (Ropret, 2006).

Generally speaking, in previous research students showed positive attitudes towards teaching of skiing.

The research subject is the status of the teaching of skiing at FSPE in Novi Sad, as part of the elective course of Winter Outdoor Activities, the students' attitudes in the form of expectations from teaching realization, as well as attitudes towards satisfaction of expectations. The paper subject is teaching of skiing, as part of curriculum content of the elective course of Winter Outdoor Activities at FSPE of the University of Novi Sad. The aim is to analyze the curriculum of teaching of skiing, compare it with the curricula of other related educational institutions, to determine attitudes of the students of the FSPE of the University of Novi Sad, toward their expectations from teaching of skiing, their attitudes on the level of satisfaction of expectations, as well as to compare the attitudes between the groups of students defined based on the level of adoption of elements of skiing.

METHODS

Subjects

The sample was selected on the basis of several characteristics defined by the very character of teaching contents and the status of the course (students who have chosen skiing as winter outdoor activity and year of study they are attending), and it consisted of 78 third year students of the FSPE in Novi Sad, of which 28 were female-students and 50 were male-students.

Procedure

Five-point Likert scale of attitudes created by the author for this specific research was used as a measuring instrument. The first scale of attitudes (Table 1) is created for gathering information on attitudes of students before the realization of the teaching of skiing at Kopaonik and contains ten stands or statements. The second scale of attitudes (Table 2) is created for gathering information on attitudes after the implementation of teaching of skiing and contains twelve stands or statements.

By defining the instrument, the same levels of compliance with the given statements were provided, in a following manner: 1 – *I strongly disagree*; 2 – *I disagree to a significant level*; 3 – *I do not have a clearly defined attitude toward the above claim or statement*; 4 – *I agree to a significant level* and 5 – *I strongly agree with the given claim or statement.*

Table 1 Given observations, claims or statements and possible levels of compliance prior to the realization of teaching of skiing

Observation, claim, statement	Level of compliance				
A1 – When it comes to the stay and realization of teaching of skiing, I expect to acquire new knowledge and skills					
A2 – Learning to ski is an opportunity to apply knowledge and skills previously acquired at FSPE					
A3 – In addition to skiing skill, stay on the mountain is also an opportunity to gain new friends and getting to know this region					
A4 – Equipment quality (clothing, protective equipment, skis, boots, poles) will significantly affect the quality of work					
A5 – Professional commitment of teachers – instructors (working methods, the choice of means, modes, space...) will be at a high level, and will allow me to master the art of skiing					
A6 – Going skiing is my chance to rest, to go away from the area where I live, and to have fun					
A7 – Before going skiing, I have assembled a significant number of high quality information on this activity and it will greatly help me					
A8 – General and specific physical preparation of students is not significant for realization of teaching of skiing and does not have a positive impact on the quality of mastering skiing skills					
A9 – Before going skiing, I invested a significant effort to raise general and specific motor abilities (for the activity of skiing) by individual training					
A10 – Knowledge of teaching-scientific fields, studied at FSPE, will significantly contribute to overcome skiing skills					

Table 2 Given observation, claims or statements and possible levels of compliance after teaching of skiing

Observation, claim, statement	Level of compliance				
B1 – Realized activity was wonderful and useful experience on the mountain					
B2 – I could have make better use of the past seven days					
B3 – After the seven days, I want to come back to this, or any other mountain again, and as soon as possible					
B4 – I am very satisfies with what I have seen, experienced and learned					
B5 – Characteristics of the space and time available were well used by the teacher – instructor in order to achieve better results regarding skiing knowledge					
B6 – Scoring was conducted after a quality insight into the level of my knowledge of skiing, and after completion of training					
B7 – Chosen and applied methods of work of teachers – instructors significantly positively affected my level of acquired skills of skiing					
B8 – I would achieve significantly more progress in the art of skiing, if my equipment (skis, boots...) was adequate					
B9 – Accommodation and food have negatively affected my level of acquired skills of skiing					
B10 – If I came better physically prepared to the realization of teaching of skiing, I would achieve a higher level of skiing knowledge					
B11 – Existing knowledge obtained in studies at FSPE, contributed significantly to the quality of adopting the knowledge and skills of skiing					
B12 – Quality previous information about the activities of skiing (mountains, snow, skiing, tracks, equipment, preparation...) had a significant impact on the quality of the adoption of skiing skills					

After defining the research subject, instrument and respondents were prepared for the implementation of collecting information on the students' attitudes by using the survey as research technique. The instrument – the questionnaire is compiled based on the authors' experiences and wish to collect the necessary information for reaching a conclusion on the students' attitudes. The students who opted for skiing as the content within the course of Winter Outdoor Activities were "available" to the authors. Teaching of skiing was realized at the Mountain of Kopaonik within the period of 7 days during the month of February 2013. The respondents – students were adequately prepared (acquainted with the idea, their possible tasks, using information obtained...) and they have voluntarily accepted the role of respondents in the research and as such well collaborated with the authors in the realization of information collection. Gathering information was conducted in three phases: before going to the realization of teaching of skiing – through surveying, after the completion of training – through evaluation of the level of adoption of monitored elements of skiing and after the completion of training and evaluation – through surveying.

Statistical analysis

Nonparametric methods of data processing were used in the paper. In order to describe the sample of respondents the frequency of occurrence of information on the characteristics of the sample was determined based on previous stays on the mountain in winter conditions as well as the possible attendance of the ski school before the realization of the teaching of skiing with the faculty. Further towards the realization of the research at the first step of processing the collected information, basic descriptive indicators and frequency of occurrence and percentage rates of attitudes were determined for the total sample prior to the realization of teaching of skiing, and then the same was performed for the sample after the realization of teaching. After the division of participants into groups according to their level of acquisition of skiing technique (average scores derived from the score 1 and score 2, which will be explained in the sequel), basic descriptive indicators of the level of success for both scores were determined. Finally, the values of chi-square test and the values of statistical significance of differences between the variables (attitudes) were calculated following the implementation of teaching of skiing.

RESULTS

A total of 22 variables of were analyzed of which 10 (A1-A10) were defined before the realization of practical teaching of skiing (expectations), and the other 12 (B1-B12) represented the attitudes (impressions) after the completion of the training of skiing at Kopaonik.

Discrimination of measurements of each applied attitudinal variables was checked using the standardized skewness (coefficient of curvature) and standardized kurtosis (coefficient of elongation). If the curvature of the curve is greater than 1.96 (for the level of p=0.05) and 2.58 (for the level of p=0.01), it is considered that these variables do not possess a valid discrimination (sensitivity). Kurtosis and skewness are also used as confirmation of the orientation of students toward one or another level of compliance with the given statements. The same point to the fact that the list of statements is not standardized but made up for this research. Given that these are the data that are arranged, in ascending or descending intensity, without intervality of measurement and no real zero (ordinal scale), the analysis of the research results included the frequencies of occurrence of the level of compliance with the given statements and their percentage distribution.

The following table presents the results of the analysis of the sample on the basis of previous stays for skiing as well as the number of those who have attended a particular ski school during the stay.

Table 3 Information on the stay and ski school attended so far

Variable	1 – no		2 – yes	
	f	%	f	%
Stay skiing so far	55	69,6	24	30,4
Ski school so far	68	86,1	11	13,9

It can be concluded that only 30% of the total number of students – respondents in this research earlier visited the mountains in winter conditions, and that even 86.1% of them during that stay did not attend ski school. With regard to the percentage ratio of those who have previously stayed or not at the mountain in winter conditions, within this research we performed an analysis of the differences between the groups established by the criterion of previous stay, for certain variables (before and after teaching).

Tables 4 and 5 show the frequency of occurrence and percentage representation of attitudes before and after the training within the teaching of skiing.

Table 4 Frequency and percentage representation of attitudes before skiing training (teaching of skiing)

	1		2		3		4		5	
Variables	f	%	f	%	f	%	f	%	f	%
A 1 (+)	0	0	0	0	1	1,3	9	11,5	68	**87,2**
A 2 (+)	0	0	2	2,6	19	24,4	22	28,2	34	**43,6**
A 3 (-)	0	0	0	0	3	3,8	15	19,2	60	**76,9**
A 4 (-)	1	1,3	3	3,8	13	16,7	33	**42,3**	28	35,9
A 5 (-)	0	0	0	0	8	10,3	11	14,1	59	**75,6**
A 6 (-)	0	0	6	7,7	10	12,8	12	15,4	50	**64,1**
A 7 (+)	4	5,1	5	6,4	23	29,5	18	23,1	28	**35,9**
A 8	27	**34,6**	18	23,1	12	15,4	14	17,9	7	9,0
A 9	15	19,2	17	21,8	23	**29,5**	17	21,8	6	7,7
A 10	1	1,3	2	2,6	17	21,8	28	35,9	30	**38,5**

Table 5 Frequency and percentage representation of attitudes after skiing training (teaching of skiing)

Variables	1		2		3		4		5	
	f	%	f	%	f	%	f	%	f	%
B 1	0	0	0	0	0	0	6	7,7	72	**92,3**
B 2	48	**61,5**	14	17,9	6	7,7	5	6,4	5	6,4
B 3	0	0	0	0	2	2,6	9	11,5	67	**85,9**
B 4	0	0	0	0	0	0	9	11,5	69	**88,5**
B 5	0	0	0	0	2	2,6	6	7,7	70	**89,7**
B 6	1	1,3	0	0	4	5,1	7	9,0	66	**84,6**
B 7	0	0	0	0	2	2,6	4	5,1	72	**92,3**
B 8	41	**52,6**	15	19,2	10	12,8	9	11,5	3	3,8
B 9	69	**88,5**	5	6,4	2	2,6	1	1,3	1	1,3
B 10	40	**51,3**	8	10,3	12	15,4	8	10,3	10	12,8
B 11	1	1,3	4	5,1	14	17,9	23	29,5	36	**46,2**
B 12	4	5,1	2	2,6	9	11,5	24	30,8	39	**50**

The values shown indicate the frequency of occurrence of each of the levels of compliance with the above statements, as well as the percentage of representation for the same statements. Percentage values of the most represented levels of compliance for each of these attitudes are highlighted – bolded in the study.

Table 6 Basic descriptive indicators of level of successful mastered techniques – snowplough and parallel turns

	AM	AM-sg	Sk	Ku	Min	Max
Score 1	8,656	0,0838	-0,103	-0,322	7	10
Score 2	8,695	0,0780	-0,237	-0,310	7	10

Table 7 The values of the chi-square test and the significance of differences in variables (attitudes) after the implementation of teaching of skiing.

	Chi ^{2}	***p***
B1	0,169	0,919
B2	0,163	0,922
B3	0,983	0,612
B4	0,202	0,904
B5	1,812	0,404
B6	0,412	0,814
B7	1,083	0,582
B8	0,121	0,941
B9	1,137	0,566
B10	9,190	**0,010**
B11	0,335	0,846
B12	3,433	0,180

Table 6 shows basic descriptive indicators of the level of adoption expressed by scores of students' technique at the final test of practical part of teaching of skiing, while Table 7 shows the differentiating (Chi^2) of these groups regarding the attitudes after the realization of skiing training and significance of this differentiation (*p*).

DISCUSSION

Individually, by attitudinal variables before skiing training, in a significant number of treated variables students usually highly positively agreed (level 4, 5 or cumulatively 4 and 5) with statements (A1 87,2 %; A2 50%; A3 84,2 %; A4 78,2%; A5 75,6%; A6 79,5%; A7 59%; A10 74,4%) while in the variable A8 most students chose 1 and 2, cumulatively 57.7%, or disagreed with the given statement. Regarding the variable A9 it was shown that a significant number of students (23 or 29.5%) had insufficiently clear orientation and that regarding the cumulative comparison there were more respondents who have not invested considerable effort in preparing for the training than those who have (41% vs. 21.5%).

As for the frequency of occurrence of attitudes after skiing training, we can clearly conclude that the attitudes of students were more confident, i.e. students were more clearly oriented regarding most of the attitudes (B1 92,3%; B3 85,9%; B4 88,5%; B5 89,7%; B6 84,6%; B7 92,3%; B11 46,2%; B12 50%).

Overall, small number of students opted for level 3, which was defined as neutral. In four variables students were predominantly oriented to disagree with the given statements, given that these statements were pointing to the possibility of more quality use of time of stay at the mountain, the quality of equipment and accommodation, as well as the level of preparedness before coming to training (B2 52,6%; B8 52,6%; B9 88,5% ; B10 51,3%).

After completed training, i.e. realization of practical teaching of skiing, the last day during the stay at the mountains the students were subjected by the instructor to testing of the level of skiing technique mastered – snowplough turn in frozen form (score 1) and basic parallel turn (score 2). It can be concluded that the scores of the respondents were distributed normally. After descriptive analysis of the scores of all students, the students were divided into 3 groups according to the level of adoption of the monitored techniques, i.e. the final scores. Given that there was no student with a score of 6, groups were divided as follows:

- The first group – students with scores in the range of 7 to 8 (9 students),
- The second group – students with scores in the range of 8 to 9 (39 students)
- The third group – students who performed best, with scores in the range of 9 to 10 (29 students).

Presented high levels of statistical significance (*p* values) for almost all variables (except B10) indicate the lack of a statistically significant difference between groups defined by the score as the criterion. The only variable in which statistical difference was found between the variables in groups (Chi^2=9.190 and p=0.010) refers to whether students believe that they would achieve a higher level of acquired skills of skiing if they prepared better physically. In this variable, students with the lowest grades, nine of them, had positive attitudes.

CONCLUSION

Determining the students' attitudes toward different objects and in different areas has been frequently applied method, especially in the fields of psychology, pedagogy, medicine, and even in the area of physical education. Overall, the students, in studies so far known to the authors, have shown a positive attitude towards the Winter Outdoor Activities – Skiing. General and specific competencies of a graduate student of FSPE would have to be a positive outcome of the high-quality education and prerequisite for its competitiveness in the market. Knowledge in the field of skiing represents specific competence. The course of Winter Outdoor Activities is conceived with the aim of contributing to the achievement of complete profile of graduate student of FSPE. The research results indicate a majority of positive attitudes towards expectations from teaching of skiing in the function of acquiring new knowledge and skills, contributions of previously acquired knowledge through other educational and scientific fields previously studied at faculty, professional commitment of the teacher – instructor as a function of mastering the skills of skiing, as well as the very stay at the mountain. Thanks to the quality of the realization of the entire teaching of skiing (organization, space, time, conditions...) students also showed highly positive attitudes on realized expectations. After the realization of the training, a high level of acquired skills of skiing was determined by the subject teacher and instructor for each group. The process of determining the possible differences in attitudes between the students of different levels of adoption, showed the absence of statistically significant differences except for extremely high positive attitudes of students of lower levels of acquisition towards the importance of physical fitness for the adoption of skiing skills. Regardless of the possible drawbacks, there is the possibility of using the results obtained for promoting of the teaching (curriculum evaluation).

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HIP FLEXIBILITY AND SUCCESS RATE IN PERFORMING RHYTHMIC GYMNASTICS

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SUMMARY

Rhythmic gymnastics (RG) is a sport which strongly requires the highest level and high quality of flexibility skills. The widespread use of hip flexion, extension and abduction in RG is so evident and suggest us to verify its' importance in RG performance. With the aim to examine the significance of hip flexibility for the successful performing of Physical Education (PE) students at RG course, the cross-sectional study was conducted in a group of 54 PE students (F=37, M=17), aged 21.2±1.79 (F=21.65±1.44 years, M=20.24±2.14 years). Active range of motion of the hip joints was established by four measuring instruments: hip flexion (MFLPLK, in °), hip extension (MFLZLP, in °), hip abduction- lying on the side (MFLOLB, in °), and hips abduction- side split while lying on the back (MFLRLK, in °). The mean value of the practical exam marks (it ranges from 6 to 10) was taken as criterion variable. The data were analyzed (descriptive statistics, correlations and regression analysis) using the IBM SPSS 21.0. Skewness indicated that female students achieved the best results in fourth test (hips abduction) and male students were good in hip flexion. Although significant correlation of success and hip flexion and hip abduction is found (r=0.46 and r=0.49, respectively) regression analysis indicated statistically significant influence of hip flexibility parameters only at multivariate level (p<0.04).

Keywords: PE students, hip joints, range of motion, cross-sectional study

INTRODUCTION

The word *flexibility* is derived from the Latin (lat. *flectere*=to bend) and is defined as the „ability to be bent“. In physical education (PE), sports medicine, and health sciences, so-called normal flexibility is defined as the range of motion (ROM) available in a joint or group of joints (Hebbelinck, 1988). For some others, flexibility is the ability to move a single joint or series of joints smoothly and easily through an unrestricted, pain-free ROM (Kisner & Colby, 2002). We differ two types of flexibility: static and dynamic. Dynamic, or functional flexibility (Clippinger-Robertson, 1988), referes to the ability to use a range of joint movement in the preformance of a physical activity at either normal or rapid speed (Corbin & Noble, 1980; according to Alter, 2004).

What stands out is that flexibility does not exist as a general characteristic but is specific to a particular joint (Alter, 2004) (e.g. adequate ROM in the hip does not ensure adequate ROM in the shoulder; similarly, sufficient ROM in one hip may not mean sufficient ROM in the other hip). It is also specific to a given group of sports. Furthermore, even within sports groups, particular patterns of flexibility are related to frequent or unique joint movements. In some sports, such as Rhythmic gymnastics (RG), athletes need a high ROM to perform certain movements or acquire specific static positions (Harvey & Mansfield, 2000) which makes the flexibility a decisive motor quality in performance. A gymnast who lacks flexibility in a joint linked to the execution of a particular movement will increase the risk of injury by having to use other compensatory mechanisms. This also causes uncoordinated movements and low ROM, with a marked decrease in mechanical efficiency, poorer performance and increased chance of injury (Shellock & Prentice, 1985). This poor performance compared to the established model also receives score penalties according to Code of Points (FIG, 2013).

RG is a competitive sport that due to its aesthetic and technical requirements makes athletes seek to maximize their technical performance (Frutuoso, da Costa Silva, Bertoli, & de la Rocha Freitas, 2013). These are the same high demands on efficiency, expressed in the need for a high level of motor characteristics with primary development of flexibility, agility (as a set of coordination abilities), jumping ability, overall stamina (Zhumanova, 2013). Greater ROMs are found in rhythmic gymnasts

(Menezes & Fernandes Filho, 2006; Douda, Toubekis, Avloniti & Tokmakidis, 2008) through studies aimed at identifying potential performance-related variables or comparing groups with different levels of performance. Overall, female population shows greater flexibility than male (Araujo, 2008; according to Gómez-Landero Rodríguez, López Bedoya, & Vernetta Santana, 2013).

As already mentioned RG is rich in movements that require large, sometimes extreme amplitudes and mobility of all of the joints (mostly the hip joints), whether the pivots, balance or jumping as fundamental body elements. Achieving these positions can be problematic for some, and the time required to accomplish them has been shown to be extensive (Sands, McNeal, Stone, Russell, & Jemni, 2006). At Faculty of Sport and Physical Education (FSPE) in Niš (Serbia) *Rhythmic gymnastics* is an obligatory course for female students in the third year (VI semester) and it's based on mastering six obligatory routines (without apparatus, rope, ball, hoop, ribbon and clubs), in 15 weeks only (135 minutes/week). *Rhythmic* is an optional course in the first year (I semester) which can attend both male and female PE students. During this course they are introduced to RG by mastering three obligatory routines (without apparatus, rope and ball), in 15 weeks also (90 minutes/week). This 15-week long period don't leave us enough space for thorough work on the development of students' flexibility, explosive strength, balance, and every other ability important for the successful performance and passing these exams. These facts prompted us to investigate the influence of the students' hip flexibility on the success rate in performing obligatory RG routines.

METHODS

Subjects

The sample comprised 54 (F=37, M=17) the first and third-year full-time students (aged 21.2±1.79) of FSPE (University of Niš, Serbia), in the academic 2011/2012 and 2012/2013 year. The perquisite for inclusion was the successfully finished practical part of the exam (optional course *Rhythmic*, i.e. obligatory course *Rhythmic gymnastics*) and student's voluntary consent.

Procedure

The measures were taken in June 2012 and February 2013, at FSPE in Niš, and the testing was conducted in agreement with the principles stated in the Helsinki Declaration (WMA, 2002). Set of predictor variables accounted for flexibility parameters, i.e. measures of the ROM of the hip joint: hip flexion (MFLPLK, in °), hip extension (MFLZLP, in °), hip abduction- lying on the side (MFLOLB, in °), and hips abduction- side split while lying on the back (MFLRLK, in °) (after Metikoš, Hofman, Prot, Pintar, & Oreb, 1989). Testing protocols were maximally implemented by authors, with the remark that for the first three tests only one (dominant) hip data were analyzed. The criterion variable (Success) was recorded as the mean value of the practical exam mark that can range from 6 to 10.

Statistical analysis

Collected data were analyzed using the Statistical Package for the Social Sciences, version 21.0 (IBM SPSS 21.0, SPSS Inc, Chicago, USA). Descriptive statistics [average value (Mean), standard deviation (SD), Range, Skewness and Kurtosis] were summarized for all variables. The influence of hip flexibility on the success rate in performing RG routines was determined by correlations and regression analysis. The level of significance was set at $p<0.05$.

RESULTS

Study results are presented in tables. The descriptive statistics data of all of the measurements are presented in Table 1. Results of Skewness indicate that the female students achieved best scores in the fourth test (MFLRLK, 0.054) and male students in the first one (MFLPLK, 0.796). The fourth test's kurtosis values (MFLRLK, ~1.7) indicate results' heterogeneity. Correlation coefficients (Tab. 2) among flexibility parameters are relatively high, but only hip flexion and abduction are highly correlated to the Success (lower correlations are found in the case of hip extension and hips abduction- side split). When speaking about Success (F=7.71±0.92, M=7.57±0.91) the practical exam marks are of great range and moderate value.

Table 1. Descriptive values of hip flexibility and success of PE students in RG courses

Gender categories	Variable	Mean±SD	Range	Skewness	Kurtosis
Females N=37	*MFLPLK*	96.92±11.46	60 - 120	-.334	2.038
	MFLZLP	66.59±10.41	45 - 90	-.202	.293
	MFLOLB	95.7±11.37	70 - 120	-.216	.289
	MFLRLK	123.35±14.01	88 - 165	.054	1.735
	Success	7.71±0.92	6.22 – 9.72	.322	-.778
Males N=17	*MFLPLK*	87.71±8.51	75 - 105	.796	.301
	MFLZLP	57.35±8.27	38 - 70	-.632	.548
	MFLOLB	80.35±8.28	65 - 95	-.196	-.610
	MFLRLK	113.82±13.29	80 - 130	-1.139	1.764
	Success	7.57±0.91	6.06 – 9.72	.502	.760
Total N=54	*MFLPLK*	94.02±11.39	60 - 120	.074	.824
	MFLZLP	63.69±10.63	38 - 90	-.047	.162
	MFLOLB	90.87±12.66	65 - 120	.047	-.354
	MFLRLK	120.35±14.37	80 - 165	-.186	1.730
	Success	7.67±0.91	6.06 – 9.72	.366	-.472

Legend: N– number, Mean- average value, SD– standard deviation, MFLPLK– hip flexion, MFLZLP- hip extension, MFLOLB- hip abduction, MFLRLK- hips abduction (side split), Success- mean value of the marks of practical part of the exam.

Table 2. Correlations between students' hip flexibility and success rate in performing RG

Variables	MFLPLK	MFLZLP	MFLOLB	MFLRLK	Success
MFLPLK	1.000000	0.482900	0.630968	0.672715	0.463011
MFLZLP	0.482900	1.000000	0.452218	0.621297	0.288863
MFLOLB	0.630968	0.452218	1.000000	0.490342	0.491271
MFLRLK	0.672715	0.621297	0.490342	1.000000	0.320901
Success	0.463011	0.288863	0.491271	0.320901	1.000000

Legend: MFLPLK– hip flexion, MFLZLP- hip extension, MFLOLB- hip abduction, MFLRLK- hips abduction (side split), Success- mean value of the marks of practical part of the exam.

Table 3. Regression analysis: influence of the female students' hip flexibility on the success rate in performing RG

$R = .5149$, $R^2 = .2652$, $F(4,32)=2.8876$, $p<.038$						
Variables	**R**	**Part R**	**Beta**	**Std. Err of Beta**	**t(32)**	**p-value**
MFLPLK	0.4224	0.1619	0.0171	0.0184	0.9282	0.360
MFLZLP	0.3043	0.0989	0.0099	0.0176	0.5619	0.578
MFLOLB	0.2972	-0.0476	-0.0050	0.0187	-0.2694	0.789
MFLRLK	0.4850	0.2739	0.0217	0.0135	1.6112	0.117

Legend: R– multiple correlation, R^2- coefficient of determination, F– value of F-test, p– value of significance, Beta- partial standard coefficient of regression, Std. Err of Beta- standard error of partial coefficient of regression, t- degree of freedom, MFLPLK– hip flexion, MFLZLP- hip extension, MFLOLB- hip abduction, MFLRLK- hips abduction (side split).

To establish the influence of students' hip flexibility measurements on success rate in performing obligatory RG routines the regression analysis method was applied. Insight into the regression analysis results of female students (Table 3) enables us to note the absence of statistically significant influence of each of the hip flexibility parameters, but at multivariate level the significant influence exists ($p<0.038$). Multiple correlation coefficient is relatively high ($R=0.5149$) and predictor variables explained 27% ($R^2=0.2652$) of the criterion variable (Success). When speaking about male subsample there are no differences in term of hip flexibility's influence on the Success as established within the female subsample, although the connection between the predictor set and criterion variable is higher ($R=0.729$) and it explains 53% ($R^2=0.5311$) of the total variance. At multivariate level hip flexibility has statistically significant influence ($p<0.045$) on the success in RG routines performance of male students (Table 4).

Table 4. Regression analysis: influence of the male students' hip flexibility on the success rate in performing RG

R= .7288, R²= .5311, F(4,12)= 3.3983, p<.045						
Variables	**R**	**Part R**	**Beta**	**Std. Err of Beta**	**t(12)**	**p**
MFLPLK	0.6374	0.4113	0.0434	0.0278	1.5632	0.144
MFLZLP	0.2323	-0.0409	-0.0034	0.0240	-0.1420	0.889
MFLOLB	0.4878	0.3310	0.0291	0.0239	1.2152	0.248
MFLRLK	0.5167	0.3518	0.0197	0.0151	1.3018	0.217

Legend: R– multiple correlation, R^2- coefficient of determination, F– value of F-test, p– value of significance, Beta-partial standard coefficient of regression, Std. Err of Beta- standard error of partial coefficient of regression, t- degree of freedom, MFLPLK– hip flexion, MFLZLP- hip extension, MFLOLB- hip abduction, MFLRLK- hips abduction (side split).

DISCUSSION AND CONCLUSION

Many studies examined the effects of RG classes on students' flexibility and some noted the low levels of flexibility (Babiy, 2014). Radoš, Furjan-Mandić i Horvatin Fučkar (2014) did their one-year study on 45 female students of Faculty of Kinesiology (Zagreb, Croatia) and tried to determine the influence of RG course (4h/week) on students' flexibility. The gained results confirmed enhancement of the functional ROM by means of stretching exercise which is widely used in the RG teaching process. For six weeks only (Piazza, Battaglia, Fiorilli, Innocenti, Iuliano, et al., 2014) 10-13-year old RGs have enhanced the hip abduction (pre: 86.2±10.6°, post: 87.3±11.7°), and after six months of RG training specific flexibility improvement cannot fail (Douda, Avloniti, Kasabalis, & Tokmakidis, 2007). Everything mentioned above gave us a strong reason to assess the dynamic hip flexibility of PE students and to use the obtained results for making the new strategies (e.g. thorought work on flexibility enhancement, if neccessary) for improving their RG marks.

Those four flexibility tests are chosen for this study cause being in accordance with widespread use of hip flexion, extension and abduction in RG routines in general. The obtained results are in compliance with the statement that hip flexibility is of great importance for the RG practicing and performing (Douda et al., 2008; Piaza et al., 2014, Radoš et al., 2014): regression analysis within each subsample confirmed that chosen predictor set has statistically significant influence on the Success rate in performing RG; regression analysis performed on total sample (N=54) emphasized the significant influence of hips abduction on the Success (p=0.047). High correlations of hip flexion and abduction and the Success rate (r=0.46 and r=0.49, respectively) can be explained by the fact that those movements are present in every obligatory routine of these courses and the level of their performance is one of the criteria (among others) affecting students' mark.

Modern RG has high demands on efficiency expressed in the need for a high level of motor abilities with primarily development of flexibility (Zhumanova, 2013). It is sport that requires the athletes to achieve relatively large ranges of motions (limb positions are beyond the norm) and often their chances to win are based on this ability. Achieving these positions can be problematic to PE students for several reasons (inadequate body proportions, excess body fat, previous practicing of the sport that doesn't require well developed flexibility), and the time required to reach some minimum level has been shown to be extensive (Sands et al., 2006). At FSPE in Niš, students have 15 weeks only (duration of both of the courses) to acquire three, i.e. six unknown routines and there isn't much time left to dedicate it to the development of the basic skills necessary for the RG practice (first few weeks are oriented toward introduction to RG basic body elements and toward development of lower limbs explosive strength, balance and whole-body flexibility). Besides, they are already in certain ages which are concerned to be inadequate for flexibility development (it's in childhood that lays the foundation of the future great sports achievements) and very often they show no interest in enhancing this ability due to fear of injury and presence of pain, mostly.

Although longitudinal study is the only study design that could give us the right answers to our many questions, we truly believe that practicing of those obligatory RG routines have enhanced the students' hip flexibility, at least a bit. Furthermore, another study limitation are performed flexibility tests. Namely, all of the tests are standardized and demand subjects to be in lying positions while doing those movements. That body position means the reducement of the gravity influence and facilitating of the specific movement performance, which is not the case for those movements' performance in routines when the gravity influence is much greater (in standing positions every hip movement means defiance to the gravity). The next step is more detailed estimation of this ability and scientific confirmation of certain assumptions.

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Interdisciplinary

A COMPARISON OF PSYCHOLOGICAL SKILLS AND TRAITS IN MALE HANDBALL PLAYERS OF DIFFERENT AGE GROUPS

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SUMMARY

The goals of this research are to determine the differences in the personality traits, psychological skills and optimism among handball players in different age groups (1) and to determine the correlations between these characteristics (2). The research was conducted on a sample of 78 subjects, members of one handball team (Prvo plinarsko društvo Zagreb), in the beginning of 2015. In this study, three instruments from the battery Multidimensional Scale of Sports' Psychological Talents (MSSPT) are used for the first time. The results show that no differences are found between age groups of handball players in optimism and personality traits. The oldest age group (age of 18) have the experience that they are the best mentally prepared. The youngest handball players (age of 12) have the experience that they are the most motivated, confident and concentrated. Motivation is the skill with highest associated with other psychological skills. However, the Scale of the Future and Psychological Skills Scale show satisfactory reliability (except the subscale Team emphasis). Big Five Modified Inventory-10 in all subscales showed unsatisfactory reliability, so has to be improved in future studies.

Keywords: Big Five, correlations, differences, psychology, sport performance

INTRODUCTION

The *contemporary handball* game includes high intensity motor activity (basic and specific motor abilities), explosive strength, agility and speed and cardio-respiratory capacities, necessary for the performance of specific motor assignments and space orientation, as well as which are indispensable for the efficient solving of game situations (Rogulj, Nazor, Srhoj & Božin, 2006). Contemporary sport development and demands on athletes impose a need to interdisciplinary study certain sport (Abernethy, 2005; Morrow & James, 2005). Top-level athletes are often equalized among themselves in many relevant elements of sport fitness (conditioning, technical, tactical and others) (Rogulj et al., 2006). Therefore, psychological factors could play the decisive role in a competition and training, differentiating between successful and less successful teams and/or individuals. Thus, numerous studies are directed to investigate important psychological characteristics of athletes, as the essential determinants of sport efficiency. The major focus in these studies is directed in the aspect of motivation (Seifriz, Duda & Chi, 1992; Mead, Drowatzky & Hardin-Crosby, 2000), but also on psychological traits and moods (Berger, Grove, Prapavessis, & Butki, 1997). Psychological characteristics of the athletes are under influence of the cultural and social environment (Kran & Baird, 2005). Particularly important are athletes' behaviors in critical situations during a competition (James & Collins, 1997; Wiggins, 1998), or in situations which challenge anxiety (Dunn & Nielsen, 1996).

Many studies used the concept of ***psychological skills*** (Cox, Liu & Qiu, 1996; Meyers, Bourgeois, LeUnes, & Murray, 1999) to differentiate between the mental skills in various levels of sport quality, from the recreational to elite level athletes (Cox et al., 1996; Meyers et al., 1999). The association between psychological skills and sports performance in general is supported in previous studies (Morgan & Pollock, 1977; May, Veach, Reed, & Griffey, 1985), while psychological skills successfully distinguish top-level from lower-level athletes (Grossarth-Maticek, Eysenck, Rieder & Rakic, 1990). Top athletes are higher motivated and self-confident, show lower level of anxiety than lower-level athletes. Moreover, top-level athletes are more internally referenced, they are better mental prepared for competition, they are more focused on their own performance and have better concentration (Mahoney, Gabriel, & Perkins, 1987; Mahoney, 1989). The relation between psychological skills and performance level depend about the type of sport (Mahoney et al., 1987; Cox and Liu, 1993) and gender (Chantal, Guay, Dobreva-Martinova & Vallerand, 1996; Sewell and Edmondson, 1996; MacIntyre, Mahoney & Moran, 1998). ***Optimism*** is defined as expectancies for the future, and it is important feature recognized in the development of psychological talents of Olympic champions (Gould, Dieffenbach & Moffett, 2001). While pessimists are more doubtful, hesitant, and anticipate disaster, optimists assume adversity can be handled successfully (Scheier, Carver & Bridges, 1994).

The ***Big Five Model*** or the Five-Factor Model (FFM) assumes the way in which personality can be divided into a smaller number of fundamental constructs (Macdonald, Bore, & Munro, 2008). Following that theory, personality can be described by means of five factors: extraversion, agreeableness, conscientiousness, emotional stability and openness to experience (Pervin & John, 1997). Extraversion describes the amount and intensity of social interaction, activity level, the need for external stimulation and the feature of joy (Trninić, Barančić & Nazor, 2008). Agreeableness presents the quality of interpersonal orientation towards the others. Conscientiousness describes task-oriented and goal-oriented behavior and socially required impulse control, while the neuroticism defines persons who tend to feel negative emotions (anxiety, bitterness, sorrow), accompanied with maladaptive stress-coping strategies. Intellect (openness to experience) describes proactive seeking and appreciation of experience for its own sake, tolerance for the unknown and exploration of the unfamiliar (Pervin & John, 1997).

Recently, no research on the differences between personality traits, optimism and psychological skills among handball players in different age groups is conducted in Croatia. The goals of this research are: to determine the differences in the personality traits, optimism and psychological skills among handball players in different age groups (1) and to determine the correlations between their personality traits and psychological skills (2).

METHODS

Subjects

The research was conducted on a sample of 78 subjects, members of one handball team (Prvo plinarsko društvo Zagreb), in the beginning of 2015. At the level of the population of handball players in this team (the most successful in Croatia), this sample is a representative sample from the aspect of playing quality, considering that it comprised all the best handball players in Croatia. Average age of the subjects was 13.82±3.10 years, while their experience of training handball was 5.36±2.94 years. Only six players won a medal in senior state championship, 11 of them won medals in junior state championship, 5 of them won medals on junior European championship, while 10 of the mare members of junior national team.

Measuring instruments

In this study, three instruments from the battery *Multidimensional Scale of Sports' Psychological Talents (MSSPT)* are used. The theoretical frameworks of these three instruments are obtained from the original measuring instruments and belonging theoretical frameworks, but with modified items, in order to obtain quite new battery of scales with the intention to comprise important psychological talents needed for obtaining top performances in variety of sports. All three instruments used 5-level Likert-type estimation scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

Scale of the Future (SOF) is modified The revised Life Orientation Test (LOT-R; Scheier, Carver, & Bridges, 1994), a 10-item scale that assesses individual levels of optimism. In this study, the reliability type internal consistency (Cronbach's alpha) is satisfying, i.e. α=0.70. *Psychological Skills Scale* is a modified version of The Psychological Skills Inventory for Sports (PSIS-R-5), 46-item scale, distributed in six subscales (Mahoney et al., 1987). This research revealed a six-factor structure, with the reliabilities of the aspects: Anxiety (9 items, α=0.71), Mental preparation (6 items, α=0.76), Motivation (8 items, α=0.82), Team emphasis (8 items, α=0.29), Concentration (8 items, α=0.52) and Confidence (9 items, α=0.71). For measuring personality is used *Big Five Modified Inventory-10*, a modified 10-item short version of the Big Five Inventory (BFI-10; Rammstedt & John, 2007). Each trait is measured by two items. Internal consistency reliabilities in this research were low and not satisfying: Extraversion α=0.35, Agreeableness α=0.23, Conscientiousness α=0.39, Neuroticism α=-0.10, Intellect α=0.34.

Procedure

According to the Ethical Codex of the Croatian Psychological Chamber, the measurement of personality traits was carried out by a psychologist, one of the authors of the paper (J.S.). The subjects voluntarily and anonymously took part in the research, with the consent of their coaches, clubs' managements and themselves, as well as with the parents' informed consent for the players younger than 18 years of age.

Statistical analysis

Kruskal Wallis test is used for comparison the differences in the psychological skills, personality traits and optimism, according to the independent variable age group. Pearson's product moment coefficients of correlations are used for calculating intercorrelations between psychological skills and personality traits, as well as with optimism. Reliability type internal consistency is calculated (Cronbach's alpha) for all scales of all questionnaires. Data analyses were performed using the statistical program IBM SPSS 20.0, while all statistical significances are commented on the level of $p<0.05$.

RESULTS

Between age groups of handball players in their personality traits and optimism, there were no statistical significant differences (Table 1).

Table 1 – Differences between age groups of handball players in their personality traits and optimism

Personality trait	Age	Mean	Std. Deviation	95% Confidence Interval for Mean		Kruskal-Wallis test (p)
				Lower Bound	Upper Bound	
extraversion	12 years	4.16	0.54	2.93	3.35	0.59
	14 years	**3.82**	0.95	3.40	4.24	
	16 years	4.06	0.95	3.58	4.53	
	18 years	**4.20**	0.86	3.59	4.81	
consciousness	12 years	**3.36**	0.83	3.04	3.68	0.48
	14 years	3.59	0.63	3.31	3.87	
	16 years	3.53	0.78	3.14	3.91	
	18 years	**3.60**	0.74	3.07	4.13	
agreeableness	12 years	4.09	0.79	3.78	4.40	0.36
	14 years	4.41	0.48	4.20	4.62	
	16 years	**3.94**	0.76	3.56	4.32	
	18 years	**4.45**	0.64	3.99	4.91	
openness to experience	12 years	3.96	0.72	4.15	4.71	0.12
	14 years	3.70	0.43	4.35	4.74	
	16 years	**3.64**	0.89	3.61	4.50	
	18 years	**4.30**	0.67	4.17	5.13	
neuroticism	12 years	4.25	0.67	3.99	4.51	0.88
	14 years	4.16	1.13	3.66	4.66	
	16 years	**3.94**	1.24	3.33	4.56	
	18 years	**4.45**	0.72	3.93	4.97	
optimism	12 years	**4.12**	0.47	3.91	4.32	0.68
	14 years	4.05	0.56	3.65	4.45	
	16 years	**3.88**	0.65	3.56	4.20	
	18 years	4.05	0.51	3.94	4.17	

Between age groups of handball players in their psychological skills, statistically significant differences are found in motivation, confidence, mental preparedness and concentration (Table 2). The oldest age group (age of 18) have the experience that they are the best mentally prepared. The youngest handball players (age of 12) have the experience that they are the most motivated, confident and concentrated.

Table 2 – Differences between age groups of handball players in their psychological skills

Psychological skill	Age	Mean	Std. Deviation	95% Confidence Interval for Mean		Kruskal-Wallis test (p)
				Lower Bound	Upper Bound	
motivation	12 years	**4.67**	0.52	3.85	4.25	**0.01**
	14 years	4.64	0.72	4.03	4.68	
	16 years	**4.24**	0.90	3.45	4.34	
	18 years	4.63	0.77	3.07	4.18	
confidence	12 years	**4.21**	0.43	2.65	2.98	**0.00**
	14 years	3.87	0.49	3.53	3.96	
	16 years	**3.13**	0.93	2.96	3.88	
	18 years	4.14	0.74	3.61	4.67	
anxiety	12 years	2.65	0.67	2.39	2.91	0.37
	14 years	2.56	0.56	2.31	2.81	
	16 years	2.77	0.62	2.46	3.07	
	18 years	2.39	0.53	2.01	2.77	
mental preparedness	12 years	2.74	0.74	2.45	3.02	**0.03**
	14 years	2.62	0.99	2.18	3.06	
	16 years	**2.50**	0.78	2.11	2.89	
	18 years	**3.48**	0.87	2.86	4.10	
team emphasis	12 years	3.68	0.50	3.49	3.88	0.38
	14 years	3.86	0.38	3.34	3.68	
	16 years	3.63	0.43	3.05	3.47	
	18 years	3.59	0.53	2.80	3.57	
concentration	12 years	**3.65**	0.49	2.38	2.75	**0.00**
	14 years	3.15	0.45	2.85	3.25	
	16 years	**3.02**	0.66	2.68	3.34	
	18 years	3.13	0.50	3.00	3.71	

About the correlations between personality traits, psychological skills and optimism of handball players (Table 3), it could be noticed that among associations between psychological skills only, the highest statistically significant positive correlation is found between the concentration and confidence. Among associations between personality traits and optimism only, the highest statistically significant positive correlations are found between the consciousness and agreeableness, as well as consciousness and optimism. When considering correlations between personality traits, psychological skills and optimism, the highest statistically significant positive correlations are found between the motivation with: agreeableness, optimism and neuroticism.

Table 3 – Correlations between personality traits, psychological skills and optimism of handball players

	motivation	confidence	anxiety	mental preparedness	team emphasis	concentration
motivation	1	.202	.074	.087	.010	-.008
confidence		1	-.231*	.116	-.245*	.662**
anxiety			1	.024	.054	-.113
mental preparedness				1	-.170	.122
team emphasis					1	-.125
concentration						1
optimism	.359**	.327**	-.039	.055	-.079	.100
extraversion	.101	.085	-.079	.110	-.050	.148
consciousness	.101	.019	-.135	.144	.044	-.046
agreeableness	.376**	.312**	-.062	.107	.094	.043
openness to experience	-.043	-.074	.172	-.180	.209	.176
neuroticism	.332**	.271*	.004	.259*	.076	-.009
	optimism	extraversion	consciousness	agreeableness	openness to experience	neuroticism
optimism	1	.267*	.412**	.381**	-.177	.287*
extraversion		1	-.090	-.145	-.073	.319**
consciousness			1	.508**	-.263*	-.027
agreeableness				1	-.029	.112
openness to experience					1	.019
neuroticism						1

However, the *Scale of the Future* and *Psychological Skills Scale* show satisfactory reliability (except the subscale of *Team emphasis*). *Big Five Modified Inventory-10* in all subscales showed unsatisfactory reliability.

DISCUSSION

This is a pilot study in using three measuring instruments from the battery Multidimensional Scale of Sports' Psychological Talents (MSSPT). In spite of the fact that theoretical frameworks of these three instruments are obtained from the original measuring instruments and belonging theoretical frameworks, the *Scale of the Future* and *Psychological Skills Scale* (*PSS*) show satisfactory reliability (except the subscale *Team emphasis* in *PSS*). *Big Five Modified Inventory-10 (BFMI-10)* in all subscales showed unsatisfactory reliability, so it has to be improved in future studies. Thus, all results obtained from the subscale *Team emphasis* or *BFMI-10,* have to be taken with a reserve. Unreliable scales of *BFMI-10* could be a reason why there were no differences between age groups of handball players in their personality traits.

The oldest age group (age of 18) experienced the highest level of mental preparedness. Previous studies reported that among all physical, technical and mental characteristics, mental preparedness provided the only statistically significant link with performance level favouring elite athletes (Orlick & Partington, 1988). Therefore, it seems valuable to give more attention during training to developing this psychological skill in talented youth athletes (Elferink-Gemser, Visscher & Lemmink, 2008).

Why the youngest handball players (age of 12) in this study experienced the highest level of motivation, confidence and concentration, it is unclear. One possible explanation should lead to a high quality of trainer's work. Second explanation could be the initial enthusiasm, which is still not decreased, in the moment of testing.

Motivation is the skill with highest associated with other psychological skills. However, these results are in line with the conclusion that the motivation and mental preparation could be used as useful indicators for differentiation purposes between elite and sub-elite athletes (Weinberg & Gould, 2003; Soyer, 2012). However, it is unclear whether the athletes have better athletic performance because of their high motivation and are more motivated because of their high quality sports performance (Elferink-Gemser et al., 2008).

In practice, the coach is helpful to stimulate the development of psychological skills, but also the optimism and desirable psychological traits, while the particular attention should be given to the motivation. The main shortcoming of the research is its pilot character, performed on small representative samples of participants (which can reflect the situation in only one team, with particular way of coaching). The biggest benefit of this research is the fact that preliminary application of three instruments from the battery Multidimensional Scale of Sports' Psychological Talents gave psychometrically satisfying and encouraging results for PSS and SOF, while BFMI-10 probably has to be improved, adding new items. In future research it would be useful to verify the psychometric characteristics of these instruments, on larger and more representative samples of athletes (not only male handball players from one single team), differentiated by gender, level of sport excellence, type of sport, age group, etc.

CONCLUSION

The results show no differences between age groups of handball players in optimism and personality traits. According to self-estimations, the oldest age group (age of 18) is the best mentally prepared, while the youngest handball players (age of 12) are the most motivated, confident and concentrated. Motivation is the skill with highest associated with other psychological skills. Scale of the Future and Psychological Skills Scale show satisfactory reliability (except the subscale Team emphasis), while Big Five Modified Inventory-10 showed unsatisfactory reliability, so has to be improved in future studies. The results provide the information relevant for coaches' work.

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RELATIONS BETWEEN MORPHOLOGICAL DIMENSIONS AND AEROBIC CAPACITY OF SPECIAL FORCES MEMBERS AT THE MINISTRY OF INTERIOR OF THE REPUBLIC OF SERBIA[1]

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SUMMARY

The aim of this study was to examine the relationship between the morphological dimensions and the aerobic capacity of special forces members at the Ministry of Interior. The study subjects were 72 special force male members, average age 34.17±5.15, average years of service 12.53±4.92, divided into four BMI groups (normal weight ≤ 24.99 kg•m^{-2}; first degree overweight 25.00-27.49 kg•m^{-2}; second degree overweight 27.50-29.99 kg•m^{-2}, and obese ≥ 30.00 kg•m^{-2}). The measured morphological dimensions were: body height and weight, and body mass index (BMI). The velocity 3000m test was used to assess aerobic capacity. Average results achieved by each BMI group for velocity 3000m test were as follows: for normal weight - Mean±SD 3.85±0.09 m/s, for first degree overweight - 3.68±0.07 m/s, for second degree overweight - 3.59±0.07 m/s, for the obese - 3.49±0.09 m/s, respectively. MANOVA results indicated the statistical significance of differences among the BMI groups in relation to the velocity 3000m test (Wilks'Lambda=0.083, F(15,177)=17.241, Sig.=0.000, Partial Eta Squared=0.563). The result of regression analysis showed the significant influence of morphological dimensions (BMI) on the results of the velocity 3000m test (R=0.408, R^2=0.167).

The results of the study implied that there are inversely proportional statistically significant relations between the morphological dimensions and the velocity 3000m. In other words, the higher level of the morphological dimensions and nutritional status (even in highly trained and selected male persons such as members of special police forces of the Ministry of the Republic of Serbia), the lower level of aerobic capacity, especially in those with a BMI greater than 30.00 kg•m^{-2}.

Key words: special forces members, BMI, aerobic capacity, velocity

INTRODUCTION

The efficiency and effectiveness or the success in the work of special forces is conditioned by the level and the structure of morphological dimensions and motor skills, and knowledge of various martial arts and the specific technical and tactical skills. According to Bonneau & Brown (1995), there are two reasons for testing the physical fitness of the police. The first reason is the uncertainty that both the existing and the future police officers possess the necessary level of physical fitness in order to perform their duty in protecting public safety. The second reason is to emphasize the importance of physical activity to health.

[1] This paper is part of the National scientific project "Effects of applied physical activity on locomotor, metabolic, psycho-social and educational status of the population of the Republic of Serbia", no. III47015, and as a part of the subproject "Effects of applied physical activity on locomotor, metabolic, psycho-social and educational status of the population of the police in the Republic of Serbia" it is financed by the Ministry of Education, Science and Technological development of the Republic of Serbia – The Cycle of Scientific Projects 2011-2015.

The increased value of the basic body dimensions - body weight and body mass index (BMI) indicate a potentially worse health status, decreased level of physical and working capacity, particularly when it comes to the type of general and specific endurance, as well as the increase in the risk of cardiovascular disease (Bonneau & Brown, 1995; Lord, 1998, Australian Federal Police, 2004; Sorensen 2005; Blagojević, Dopsaj, & Vučković, 2006). According to Djordjević & Mitrović (2015), the first negative effects of work on police officers can be identified based on the changes in morphological dimensions, and on motor and functional abilities. Practice has shown that insufficient motor skills level represents a limiting factor for the quality performance of everyday tasks and duties of police officers (Mitrović & Vucković, 2014). For them, aerobic capacity is one of the most important motor skills to be able to respond adequately to all kinds of tasks set before them (Cooper Institute for Aerobics Research, 2002; Roberts, O'Dea, Boyce, & Mannix, 2002; Lonsway, 2003; Jozić, Ivanović & Janković, 2014). This is especially true for the members of special forces who need to be physically the fittest, because their physical fitness is an important prerequisite in the government fight against terrorism and extremism (Mitrović, Djordjević, and Dopsaj, 2015). According to the most published papers and textbooks in the field of sport science, aerobic capacity is considered to be the most important component or basis of physical fitness (Turley & Wilmore, 1997; Armstrong & Welsman, 2000; Radovanović et al., 2009). Bearing in mind that in the research of many authors (Bouchard, Dionne, & Simoneau, 1992; Frey & Chow, 2006; Donnelly & Lambourne, 2011) has already been pointed out to the negative impact of body weight and BMI on the aerobic capacity of the subjects, this research is an attempt to determine what are its relations among police officers, specifically the members of special police forces of the Ministry of Interior of the Republic of Serbia.

The aim of this study is to research the relations between morphological dimensions and aerobic capacity of members of special police forces of the Ministry of Interior of the Republic of Serbia, as highly trained and selected male persons.

METHODS

This research was conducted as a non-experimental case study with the use of laboratory and field testing methods. The research was conducted in winter in the Training Center "Makis" of Serbian Ministry of Interior in Belgrade, with the members of special forces of the Ministry of Interior of the Republic of Serbia.

Subjects

The subjects of the research were 72 participants, special forces male members, average age 34.17±5.15, average years of service 12.53±4.92, divided according to the World Health Organization (http://apps.who.int/bmi) into four BMI groups: (normal weight ≤ 24.99 kg•m^{-2}; 1st degree overweight 25.00-27.49 kg•m^{-2}; 2nd degree overweight 27.50-29.99 kg•m^{-2}, and obese ≥ 30.00 kg•m^{-2}).

Procedure

For the purposes of the research morphological dimensions body height and weight and BMI (predictor variable) were used, and for the assessment of aerobic capacity the velocity 3000m test was used, expressed in seconds or in the average running speed expressed in m/s (dependent variable).

Statistical analysis

The obtained data were processed using the statistical program SPSS Statistics for Windows, Version 20.0 (IBM Corp. Released, 2011). The procedures included the calculation of basic descriptive parameters; while for the identification of relations between morphological dimensions and aerobic capacity both a multivariate analysis of variance (MANOVA), and univariate analysis of variance (ANOVA) were used, as well as the regression analysis. Multivariate analysis of variance (MANOVA) and analysis of variance (ANOVA) were used to determine the differences between the examined variables in relation to the groups. Regression analysis was applied to examine the link between the BMI and aerobic capacity of special forces members.

RESULTS

Results of the descriptive statistical parameters are shown in Table 1. The members of the special forces had average height 179.87±6.15cm, body weight 89.26±10.68 kg, and BMI 27.59 kg•m^{-2}. The normal weight group consisted of 15 (20.83%) members, first degree overweight of 23 (31.94%), second degree overweight 16 (22.22%), and obese 18 (25.00%) members. From the descriptive values of the results of the tested members it could be concluded that the oldest group was the second grade overweight (34.63 years of age), and the youngest group was the normal weight group (33.68

years of age). The group with the longest years of service in the police force was a group of obese (13.42 years), and the group with the shortest years of service was the normal weight members (11.70 years). The least average BMI value also had the group of normal weight (22.62 kg•m^{-2}), and the highest values had the obese group (32.39 kg•m^{-2}). When it comes to the average velocity 3000m test, the best average result was achieved by the group of normal weight (3.85 m/s), while the weakest results had the group of the obese (3.49 m/s). All four groups of special forces members, except for the years of age and the length of service in the MoI of the Republic of Serbia, are extremely homogeneous - as suggested by the relative dispersion values, ie. the coefficient of variation (cV%), so it can be concluded that the results are valid for the interpretation and they have a valid scientific value. The highest homogeneity of results exists with the variables of BMI and velocity, and the lowest in the years of age and the length of service, and where there is the greatest dispersion of results.

Table 1. Descriptive statistics of variables according to BMI groups

BMI groups	Variable	N (%)	Mean	SD	cV%	Min	Max
Normal weight	years of age	15 (20.83)	33.68	7.21	21.41	26.53	52.74
	years of service in MoI		11.70	6.57	56.13	5.00	30.00
	BMI (kg•m^{-2})		22.62	1.13	4.98	20.73	24.57
	velocity 3000m test (m/s)		3.85	0.36	9.36	3.27	4.59
1st degree overweight	years of age	23 (31.94)	34.20	4.82	14.10	26.63	44.56
	years of service in MoI		11.98	4.44	37.03	5.00	22.00
	BMI (kg•m^{-2})		26.45	0.59	2.22	25.31	27.46
	velocity 3000m test (m/s)		3.68	0.35	9.62	3.16	4.52
2nd degree overweight	years of age	16 (22.22)	34.63	3.55	10.24	26.70	40.92
	years of service in MoI		13.11	2.93	22.33	7.50	18.00
	BMI (kg•m^{-2})		28.79	0.73	2.55	27.75	29.98
	velocity 3000m test (m/s)		3.59	0.28	7.91	3.05	4.15
Obese	years of age	18 (25.00)	34.17	5.14	15.03	29.14	49.29
	years of service in MoI		13.42	5.52	41.11	8.00	30.00
	BMI (kg•m^{-2})		32.39	1.70	5.23	30.32	35.47
	velocity 3000m test (m/s)		3.49	0.36	10.43	2.46	4.16

Legend: *N* - number of members; *Mean* - arithmetic mean; *SD* - standard deviation; *cV%* - coefficient variation; *Min.* - minimal value; *Max.* - maximum value.

Multivariate analysis of variance (MANOVA) examined the state of the difference among the BMI groups in relation to age, the years of service and average velocity 3000m test (Table 2). There is a statistically significant difference between groups of normal weight, 1st degree overweight, 2nd degree overweight and obese members in the average velocity 3000m test ($F(15,177)=17.241$; $p=0.000$; Wilks'Lambda=0.083; Partial Eta Squared=0.563). BMI groups provide explanation for 56.3% of variance results of velocity 3000m test.

Table 2. MANOVA results - BMI groups and velocity 3000m test

Effect BMI_groups	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Wilks' Lambda	0.083	17.241	15.000	177.077	**0.000**	0.563

Table 3. ANOVA results (Tests of Between-Subjects Effects)

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
BMI groups	years of age	7.020	3	2.340	0.085	0.968	0.004
	years of service	36.915	3	12.305	0.497	0.685	0.021
	velocity 3000m test	1.181	3	0.394	3.327	**0.025**	0.128

Univariate analysis of variance (ANOVA) revealed that the BMI groups in relation to age, years of service and velocity at 3000 m significantly differ among themselves only in the velocity (Table 3), and that regarding the velocity 3000 m variable, the only statistically significant differences were determined between the normal weight group and the group of the obese members of special forces (p=0.000).

Table 4. *Post Hoc* T-test according to Bonferroni - results

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
						Lower Bound	Upper Bound
Velocity 3000m test	normal weight	obese	0.364*	0.120	**0.021**	0.038	0.691
	obese	normal weight	-0.364*	0.120	**0.021**	-0.691	-0.038

The results of regression analysis with the velocity 3000 meters test as the dependent variable, and BMI as a predictor variable, are shown in Table 5. The values of the coefficient of determination (R^2 = 0.167) indicate a statistically significant effect of BMI on the velocity 3000 meters test (p=0.000). The obtained value of the coefficient of determination indicates that 16.70% of the total variability in the results of the velocity 3000 meters test is determined by body mass index (BMI), with a standard error of prediction of the velocity at a level of 0.331 m/s. The significance of the regression relation (Table 5) was confirmed by regression analysis of variance (F=14.006; p=0.000).

Table 5. Results of regression analysis

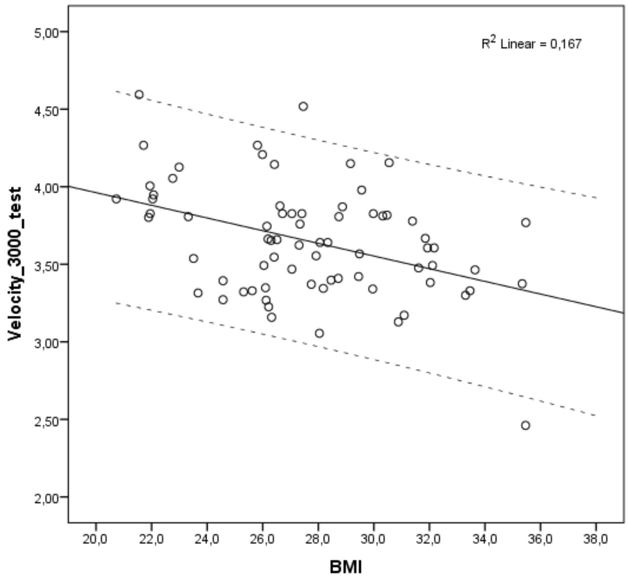
Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.408[a]	0.167	0.155	0.331
a. Predictors: (Constant), BMI				
ANOVA - Sum of Squares=1.538, df=1, Mean Square=1.538, F=14.006, Sig. =**0.000**				

Coefficients[a]					
Model	B	Std. Error	Beta	t	Sig.
(Constant)	4.779	0.305		15.690	0.000
BMI	-0.041	0.011	-0.408	-3.742	**0.000**
a. Dependent Variable: Velocity_3000_test					

Legend: *R* - coefficient of regression; *R Square* (R^2) - coefficient of determination; *Adjusted R Square* - adjusted coefficient of determination; *Std. Error* - standard error of regression; *Sig.* - significance level.

The results of regression depending on the velocity 3000m test by the special police forces members of MoI of Serbia, in relation to the values of body mass index are shown in Graph 1.

Graph 1. Regression model of the relation between the velocity 3000m test and BMI



DISCUSSION

Based on the results, we can say that this research was conducted with extremely homogenous population of special forces members of the Ministry of Interior of the Republic of Serbia, which is confirmed by the values of the coefficient of variation (cV%) of about 10% in velocity 3000 m test as a criterion test; and they are 5% lower than the criterion variable ie. BMI (Perić, 1996). Bearing in mind that the special police forces of the Republic of Serbia represent the pillar of the security system and its elite part, the assumption is that their level of physical fitness must be at a significantly higher level compared to the regular police force, and that all the members are highly trained individuals. In this study, instead of Cooper test - 12 minute run, which is using at the physical checkups to assess aerobic capacity of regular police forces of the MoI of Republic of Serbia (Professional Development Program, 2014), for the first time to assess the physical fitness of special forces the velocity 3000m test was used as one of the variants of the Cooper test, because the practice has shown that it is the most valid for the aerobic capacity assessment in special or specialized units of the army and police. It is similar to the 2 miles run test, around 3200 meters (*2 miles run*) which according to Hadžikadunić, Turković and Tabaković (2013), is using to assess aerobic capacity in the US Armed Forces (*US Army* and *US Ranger*).

Descriptive values of the results of special forces members in the groups suggest that the older groups, the larger are the values of morphological dimensions (BMI), and bearing in mind that these variables are inversely proportional to the aerobic capacity, this leads to declining results leading to significantly lower average of velocity (Malina, 2004; Djurašković, 2009). The condition when physical ie. motor abilities decline, while body weight increases, may be a consequence of the increased component of mass - which regarding to police work, is not professionally, nor health, nor economically desirable (Takač-Kostić et al, 1994; Coldiz, 1999). Bearing in mind that BMI shows the relationship between the mass and height, but does not take into account body composition, its use is limited. Perhaps the BMI values increase due to increased muscle mass and not fat, and the greater muscle mass means lower relative value of oxygen consumption, which leads to the ability of developing lower velocity in aerobic intensity zones. The relations between the BMI and average velocity at 3000 meters is best presented in Graph 1 via the regression model based on which can be perceived that members with lower values of morphological dimensions had higher aerobic capacity and vice versa, which is particularly prominent in the group of obese individuals (≥30,00 kg•m^{-2}). Members of special forces with BMI ≥30,00 kg•m^{-2}, according to all applicable medical standards fall into the category of obese patients with inadequate ie. professionally unacceptable physical status (Dopsaj, Milošević, Vučković, Blagojević, and Mudrić, 2005), which is disproportionate to the needs of police work, particularly in relation to the profile of members of special forces.

The best values of the results of morphological dimensions and aerobic capacity groups normally nourished special forces members in relation to other members of the group indicate that these values should be representative of members of special police forces of Serbia, in order to be at a high level of physical fitness and who will be able to respond best to all the activities and tasks in the domain of the Ministry of Interior of the Republic of Serbia.

Observing the results of special police units members of the Ministry of Interior of the Republic of Serbia in relation to the results of students at the Academy of Criminalistic and Police Studies (Dopsaj et al, 2010), it can be concluded that the normal weight group members as a representative group achieved better results in average velocity (3.85 m/s vs. 3.82 m/s). Students had higher values of BMI (22.62 kg•m^{-2} vs. 23.98 kg•m^{-2}). Aerobic capacity of students was evaluated using the Cooper 12-minute test run. Bearing in mind that aging inverse proportionally affects the aerobic capacity of the subjects (Ades & Toth, 2005; Mikalački, Korovljev, Čokorilo, & Kostić, 2012), this relationship results and the absence of major differences between the average results of members and students can be justified by the fact that the members of the special force were highly physically prepared and significantly older (around 34 years) compared to the Academy of Criminalistic and Police Studies (18 to 24 years).

Members of the riot police in the Ministry of Interior of the Republic of Croatia in investigating, namely Jozić, Zečić, Milković, Janković, and Šarlija (2015) ran the Cooper 12-minute run test at an average velocity of 3.47 m/s, which is at a lower level than that of members of special forces (3.65 m/s). It is assumed that the reason for these differences lies in the high physical fitness of special police forces members of Ministry of Interior of the Republic of Serbia in relation to members of Croatian Interior Ministry riot police, despite the fact that members of the special forces had a higher average BMI (27.59 kg•m^{-2} vs. 26.03 kg•m^{-2}) and although the members of the riot police were subjected to six-month training general and special physical training.

The lower value of the average velocity may have been a consequence of the high value of BMI. Members of the specialized units of law enforcement in America - *SWAT* teams (Special Weapons and Tactics Teams - https://en.wikipedia.org/wiki/SWAT) in the research by Dawes (2011) had a lower average velocity (3.47 m/s) or a lower level of aerobic capacity of members of special police forces of the Ministry of Interior of the Republic of Serbia. The results achieved by SWAT teams may be the result of high values of BMI (28.22 kg•m^{-2}), which indicates that they eat either less quality or more food, and have a higher percentage of fat or perhaps have a higher percentage of muscle tissue, which is disproportionate to aerobic capacity.

CONCLUSION

This study showed that there are statistically significant inverse proportionally relations between morphological dimensions and velocity at 3000 meters. In other words, the higher the level of morphological dimension and nutritional status even in highly trained and selected males, such as members of special police forces of the Ministry of Interior of the Republic of Serbia, the significantly lower the level of aerobic capacity, especially in those with a BMI greater than 30.00 kg•m^{-2}.

Members of the special police forces of the Ministry of Interior of the Republic of Serbia, in accordance with the acceptable professional physical status and the requirements of police work, particularly in relation to the profile of members of special forces, it would be desirable to move within the value of the normal weight group members of special forces, or within optimum weight-height relations and significantly higher levels of aerobic capacity, because the assumption is that as such they would be able to perform all the required jobs and tasks, ranging from everyday to high-risk situations.

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ENGAGING WOMEN IN SPORTS IN CROATIA CONSIDERED FROM THE ASPECTS OF SPORT ACHIEVEMENT AND ACTIVITY STATUS

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SUMMARY

This study aimed to investigate relevant factors about engagement of women in certain sports, with a purpose to retain women in sports in general. Final goal was to determine the differences in revealed latent dimensions of these relevant factors, in relation to medals won on state and international championships and sport activity status. The correlations between the dimensions of these relevant factors with number of children, work experience, age and period spent in sport are found. A total of 342 female athletes from several sports (judo, badminton, gymnastics bowling, acrobatic rock'n roll, handball, sport fishing, Association of the deaf athletes, archery, chess and basketball) were examined by specially composed the survey. The results showed that the only difference between more successful and less successful female athletes is found in environmental barriers, where higher scores have those who achieved medals on state championships. Only difference between still active and non-active athletes is found in obligation barriers (higher results for retired athletes). Small number of statistically significant differences and correlations can be explained in terms that all women athletes share similar problems.

Keywords: barriers, commitments, females, motivation, strategies

INTRODUCTION

This study has analyze the relevant factors about engagement of women in certain sports, determining the differences in these relevant factors, in relation to sport success, sport activity status and selected socio-demographic features.

The gender differences in physical activity begin to develop from early age and continue across the lifespan. Boys are physically more active than girls and men participate in sports club activities more than women do (Turpeinen, 2012). The Eurobarometer survey on sport and physical activity (Sport and physical activity, 2010) among 27 EU member states highlighted that the participation of girls and women in general is not at the same levels of participation as boys and men. Men play more different sports than women, and this disparity is particularly emphasized in age group 15-24. There is not a vast amount of literature available on the subject of women participating in sports and obstacle factors for their engaging. Furthermore, it is not easy to compare data, because of used methodology and considerable differences between countries (Acosta & Carpenter, 2012). For example, 19% of Canadian women participated in sport, compared to 35% of men, and females comprised 39% of registered competitors (Johnstone & Millar, 2012). In Islamic countries there are much more tradition related obstacles for women participating and sport is generally considered to be a masculine domain (Contomichalos, 2010). Contrary, it is a measure of progress in Western societies to have as much as possible equal number and both sexes role in sporting field. Three of the top five sports for both men and women in western countries are swimming, gym and fitness and cycling. However, female participation is heavily concentrated in swimming and fitness, while male participation is more widely spread across a range of different activities (Jones, Milward & Buriamo, 2011). The data about gender participation in different sports in England are: 90.8 % football participants are men, 86% golf participants, 71% table tennis participants , 69% cycling participants, 62% climbing and mountaineering participants, 61% tennis participants, 61% badminton participants, 60% jogging and bowling participants (Jones et al., 2011).. There are some sports with equal gender proportion, like skiing, bowling and gym. In some sports there is greater women proportion, for example swimming or diving (57% participants are women), ice skating (52% participants are women), aerobic and dance (76% participants) and yoga (82% participants). According to the Great Britain (GB) trend analysis in women's participation in sports activities from 2007-2011. (2011) 12.4% of women and 20.5% of men in population weekly participate in a sports sessions of exercise. Top women sports are: keep fit or going to the gym (13.3%), swimming (8.2%), athletics (3.4%), cycling (2.1%), and equestrian (1.2%). In some sports are less than 1% participants (dance, badminton, tennis, football, netball). In the same period, in GB the proportion of women active in sport has declined for 0.7%, while for the male proportion has raised for 0.5%. Women (54.0%) are more likely than men (39.2%) not to participate in sport, roughly similar proportions of those who do not take part in sporting activities say that they would like to do sport or active recreation (men 43.8%, women 39.6%) (Jones & Milward, 2011). Why? There some well-known barriers (Johnstone & Millar, 2012) including: psychological barriers (for example lack of confidence or negative attitudes; concerns about body weight, poor body image and low self-esteem), time-based barriers (e.g. too much responsibilities to care for children or elderly parents), interpersonal barriers (e.g. low support women's and girls' physical activity engagement; family, partner or parental belief that sport is not as important for females as for males; concerns about being perceived as unfeminine), access and opportunity barriers (e.g. cost, transportation, access to quality facilities) and programming barriers (e.g. lack of choice and variety). Similar, the data collected in national survey in Australia (Sparks, 2007) show that the most relevant barriers to women participating in sport are time related issues (family and work related), costs and lack of childcare. In some occasions there are still ideological reasons, for example belief that heavier involvement in some sports diminishes femininity and leads to unattractive muscles. The Croatian Olympic Committee (COC) determined the goal of increasing the percentage of women participating in sports. It is recommended to all of its national governing body members that there are should be at least 40 percentage of women in all sports associations by the end of 2015 (COC, 2012).

Near to the end of 2015, our article indirectly explores how close or how far is Croatian sport to the goal of COC. Therefore, this research is conducted to identify some factors for the engaging women in sports in Croatia. The purpose of this study were to identify reasons and factors of practicing sports in Croatian women, barriers that they perceive disturbing for their continued engagement in sport, either as competitors or as sport employees. Moreover, we wanted to determine what are the important issues to be addressed that could encourage greater participation of women in sports, which are specific strategies to encourage women to stay in sports, and what are the ways to improve the intense media coverage of women in sports. All these findings could allow us to create effective programs to motivate women to practice sports and to persevere in sports, either as competitors, or as sports employees.

The **goals** of this research were to determine the correlations among latent dimensions of all relevant factors about engagement of women in sports with four relevant variables (number of children, age, work experience and the period spent engaged in sports) (1). Then, further goal was to determine the differences in all relevant factors about engagement of women in sports, according to three independent variables: medals won on state and international championships, as well as depending are the women athletes (competitors) or not (2).

METHODS

Subjects

Female sport competitors and employees were surveyed as a part of this research. The questionnaires were distributed by email from December 2015 to the end of April 2015, with the aid of the Croatian Olympic Committee. The questionnaires were also returned to the researchers by email, signed by the surveyed sport practitioners (N=342) to give their informed consent to participate in the research. The average age of the surveyed female sport practitioners was 31.53±13.92 years (M±SD), a range from 14 to 74 years, their average work experience in years is 7.09±10.16, a range from 0 to 42 years and their average years spent practicing their sport is 15.18±10.48, a range from 1 to 55. Sports included in this survey are: judo 50 participants (14.6 %), badminton 18 participants (5.3%), gymnastics 24 participants (7%), bowling 16 participants (4.7%), acrobatic rock'n & roll 56 participants (16,4%), handball 26 participants (7.6%), sport fishing 50 participants (14.6%), Association of the deaf athletes 14 participants (4,1%), archery 25 participants (7.3%), chess 22 participants (6.4%) and basketball 41 participant (12%). Only 73 (21.7%) of the surveyed practitioners have not won a medal in a national level championship, while 264 (78.3%) of them have. Hundred and eighty four (56.1%) of the surveyed female sport practitioners have won a medal at an international level, while 144 (43.9%) of them have not. Two hundred and twenty two (65.3%) surveyed female sport practitioners do not have children, while 44 (12.9%) have one child, 54 (15.9%) of them have two, 19 (5.6%) of them has 3 children and only one of them (0.3%) has four or more children.

Procedure

The set of questionnaires was disseminated by belonging Croatian sport associations to female active sport competitors: the reasons for practicing certain sport, positive and negative aspects of this sport, involvement in other sports and how much time certain sport takes away from other obligations. In this research, modified items are back-translated from the following questionnaires: 'Attitudes towards women in sports' and 'Obstacles for women in sports' (Khan et al., 2012); 'Obstacles for women in sports'; 'Promoting greater involvement of women in sports'; 'Media coverage of female sports' (Sparks, 2007); 'Motivation for participation in sports' (Sport and Physical Activity, 2010). The items in all the questionnaires can be seen in previous articles about retaining of women in judo (Rendulić, Sindik & Čorak, 2013; Rendulić, Sindik & Čorak, 2014; Sindik, Rendulić, Čorak & Perinić-Lewis, 2014). All seven questionnaires used to explore women engagement in Croatian judo showed moderate to high satisfactory reliability and good construct validity, in 15 latent dimensions that are revealed (Sindik et al., 2014). In this research, the reliabilities type internal consistency for the dimensions of the questionnaires: Positive personal motives (α=0.55); Negative environment motives (α=0.60); Social motives (α=0.79); Relaxation and fun (α=0.63); Ambition and self-esteem (α=0.69); Environmental barriers (α=0.70); Obligations as barriers (α=0.64); Financial rules, traffic barriers (α=0.56); Organization of sport commitments for women (α=0.56); Organization of out-sport commitments for women (α=0.57); Specific strategies for media to improve coverage of women in sports (α=0.86); Specific strategies to encourage women to be engaged in sports – indirectly (officials; α=0.77); Specific strategies to encourage women to be engaged in sports – directly (competitors; α=0.76); Already present initiatives to encourage women to be engaged in sports (α=0.83).

Statistical analysis

In the statistical analyses of the data, the software package SPSS 20.0 is used. For determining construct validity of the questionnaires, Principal Components Analysis with (or without, in one-component solutions) Varimax Rotation are used. The results in extracted principal components (factors) in certain questionnaires are expressed in regression factor scores, and then used in further analysis (differences and correlations). The reliability type internal consistency for all components (factors) revealed was determined using Cronbach's alpha coefficients of internal consistency. The correlation analyses were performed using Spearman rank-correlation coefficients. To determine the differences between each two groups of participants, the t-test for independent samples is used. The significance of differences and correlations are commented on the probability level of $p < 0.05$.

RESULTS

Out of 36 correlations among all the components in all questionnaires with the variables: Number of children, Work experience, age and Period spent in sport, only 8 were statistically significant, positive and very low. The highest number of statistically significant correlations (4) is found between the Number of children and: Environmental barriers, Obligations as barriers, Organization of out-sport commitments for women and Directly including in sport (active competitors).

The only difference between more successful and less successful female athletes (in terms of medals won on state and international championships) is found in environmental barriers, where higher scores have those who achieved medals on state championships (Table 2). The only difference between still active and non-active athletes (Table 3) is found in obligation barriers (higher mean results for retired athletes).

Table 1 - Correlations (Spearman) among all the components in all questionnaires with the variables: Number of children, Work experience, Age and Period spent in sport

Variables	Number of children	Work experience	Age	Period spent in sport
Number of children	1	.528**	.631**	.277**
Work experience		1	.719**	.443**
Age			1	.641**
Period spent in sport				1
Environmental barriers	.126*	.071	.066	.031
Obligations as barriers	.266**	.182**	.162**	.083
Financial, rules and traffic as barriers	.049	-.023	-.016	-.009
Organization of sport commitments for women	.030	.037	.017	-.042
Organization of out-sport commitments for women	.152**	.186**	.124*	.055
Specific strategies for media	.070	.091	.054	.093
Indirectly - sport official	.080	.074	.032	-.049
Directly in sport	.123*	.080	.026	-.044
Already present initiatives involving women in sport	-.040	.003	-.060	-.037

* Correlation significant with $p<0.05$ (two-tailed)
** Correlation significant with $p<0.01$ (two-tailed)

Table 2 - Differences in All the Components in All Questionnaires according to the medals won on state and international championships

	medals on state championships	Mean	Std. Deviation	t-test
environmental barriers	no	0.24	0.36	**2.33***
	yes	**0.76**	0.55	
obligation barriers	no	0.75	0.52	0.44
	yes	0.46	0.47	
financial, traffic and rules barriers	no	0.46	0.46	0.83
	yes	0.36	0.46	
organization of sport commitments	no	0.22	0.37	0.57
	yes	0.77	0.56	
organization out of sport commitments	no	0.74	0.53	0.75
	yes	0.50	0.50	
specific strategies for media	no	0.44	0.45	-1.26
	yes	0.40	0.51	
indirect strategies for including women	no	0.40	0.55	0.86
	yes	0.30	0.44	
direct strategies for including women	no	0.30	0.59	0.90
	yes	0.36	0.45	
already present initiatives	no	0.37	0.55	1.88
	yes	0.89	0.63	
	medals on international championships	**Mean**	**Std. Deviation**	**t-test**
environmental barriers	no	0.24	0.36	0.55
	yes	0.76	0.55	
obligation barriers	no	0.75	0.52	0.02
	yes	0.46	0.47	
financial, traffic and rules barriers	no	0.46	0.46	0.11
	yes	0.40	0.45	
organization of sport commitments	no	0.39	0.39	1.03
	yes	0.30	0.45	
organization out of sport commitments	no	0.29	0.51	1.29
	yes	0.37	0.51	
specific strategies for media	no	0.37	0.46	-0.66
	yes	0.88	0.56	
indirect strategies for including women	no	0.77	0.53	1.72
	yes	0.76	0.62	
direct strategies for including women	no	0.75	0.66	0.16
	yes	0.70	0.51	
already present initiatives	no	0.58	0.54	1.95
	yes	0.58	0.54	

Table 3 - Differences in All the Components in All Questionnaires according to the fact if the athletes are still active (competitors) or not

	still active (competitor)	Mean	Std. Deviation	t-test
environmental barriers	no	0.25	0.40	0.12
	yes	0.25	0.38	
obligation barriers	no	0.71	0.53	**-1.98***
	yes	**0.84**	0.54	
financial, traffic and rules barriers	no	0.46	0.46	-0.04
	yes	0.46	0.46	
organization of sport commitments	no	0.97	0.75	-0.01
	yes	0.97	0.84	
organization out of sport commitments	no	0.95	0.90	-1.32
	yes	0.10	0.95	
specific strategies for media	no	0.65	0.82	-1.68
	yes	0.84	1.07	
indirect strategies for including women	no	0.84	0.55	0.40
	yes	0.81	0.54	
direct strategies for including women	no	0.77	0.64	0.26
	yes	0.75	0.63	
already present initiatives	no	0.65	0.52	0.64
	yes	0.61	0.53	

DISCUSSION

Small number of statistically significant differences between women athletes, as well as small number of very low correlations with socio-demographical factors, could be the most easily explained that women athletes share similar problems in their lives. The other possible explanation is possibility that in this study, authors didn't choose relevant independent variables for the comparison of women athletes. Namely, there are different features which are related with women participating in sports and different obstacle factors for their engaging, across the countries (Acosta & Carpenter, 2012). In some countries there are much more cultural tradition related obstacles for women participating in sport (e.g. in which sports, when, where, how intensive (Contomichalos, 2010). The main shortcoming of the research is convenient sample of participants, with disproportional representation of different sport, at first in number of participants from each sport. Additionally, sports from which the samples of participants belong are on the different relative levels of sports excellence (in some sports, Croatian athletes are internationally recognized as high-level athletes, while in some sports they are in fact amateurs). The highest strength of this study is the fact that after preliminary application of used measuring instruments (Sindik et al., 2014), imported questionnaires showed again psychometrically satisfying and encouraging results. In future studies it could be important to verify all the psychometric characteristics of these instruments, on larger and more representative samples of athletes, differentiated by level of sport excellence, type of sport, age group, etc. In the practice, media, local authorities, sport organizations, coaches, parents, peers and teachers could be helpful to stimulate retaining women in sport during lifetime, emphasizing their intrinsic motivation. Hiring women in various positions in sports could be suggested as a solution: they could work as coaches, judges, selectors, tournament officials, and members of sports club management or of the general committee of belonging sport associations. Giving women an opportunity to be educated for these positions is one of the prerequisites for achieving abovementioned (Sindik et al., 2014). Creating effective programs to motivate women to be engaged in sports without giving it up in the later stages of life, represents the long-term solution to the problem of female participation in sports (Sindik et al., 2014). Hence, already the results of this study could help in understanding these issues better. It could help the Croatian sport associations to improve the support given to women in sport in general.

CONCLUSION

Only difference between more successful and less successful female athletes is found in environmental barriers, where higher scores have those who achieved medals on state championships. Only difference between still active and non-active athletes is found in obligation barriers (higher mean results for retired athletes). Number of children, Work experience, age and Period spent in sport, only 8 were statistically significant, positive and very low. The highest numbers of statistically significant correlations (4) are found between the Number of children and: Environmental barriers, Obligations as barriers, Organization of out-sport commitments for women and Directly including in sport (active competitors). In spite of low number of significant differences and correlations, the results provide important information for the practice.

Acknowledgements

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COACHEs' KNOWLEDGE ABOUT EATING DISORDERS IN ATHLETES FROM AESTHETIC SPORTS: PILOT STUDY

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SUMMARY

As a part of longitudianal investigation and educational progremme for prevention of eating disorders in aestetics sports, 20 coaches participated in this investigation. They completed the questionnaire designed for coaches. Most of the coaches agreed that the disturbances of eating is a serious problem in aesthetic sports, and 50% of them said that they have had expirience to work with the athletes with this problems. Exactly 80% of them believe that the knowledge that they have is satisfactory, but existing knowledge it is not safe to identify the problem (50%). They have received through the information throught professional literature and the media (80%), while a very small number of them (about 10%) throught the experience of their colleagues, which means that they rarely talk about it. A questionnaire on specific knowledge has shown that they have basic information about disorders as well as the age with higher risks, but not a clear view on the characteristics and manifestations of the disorders. For example, they think that obese people have more psychological problems than those who do not have weight problems, and also that people who are obese can not lose weight because they "do not have sufficient will". One of the prejudices was that bulimic women are extremely skinny. The results showed that the coaches who participated in this study need further education about topics connected with eating disorders and their risks on development of athletes.

Keywords: aesthetic sports, anorexia nervosa, bulimia, education program

INTRODUCTION

Certified athletic trainers have the capacity and responsibility to play active roles as integral members of the health care team. Their frequent daily interactions with athletes help to facilitate the level of medical surveillance necessary for early detection, timely referrals, treatment follow-through, and compliance of the eating disorders (ED) and risks for their development (Bonci et al., 2008). Establishing educational initiatives for preventing disorders are of the great importance in all sports, especially in “aesthetics” ones, where demands of the sports rises pressures for thinness and athletes are at increased risk for developing eating disorders (Whisenhunt, Williamson, Drab-Hudson & Walden, 2008). Evidence showed that educational programs about eating disorders were not often sponsored by the athletic department for coaches or athletes (Turk, Prentice, Chappell & Shields, 1999).

One of the earlier studies showed that even elite coaches have insufficient capacity to identify ED and conduct early intervention, which can result in delayed treatment (Nowicka, Eli, Ng, Apitzsch & Sundgot-Borgen, 2013). The coaches from this study knew athletes with eating disorders, but they did not perceive as a problem in their sport. The majority of coaches cited difficulties in identifying ED symptoms, especially symptoms associated with bulimia nervosa. Coaches also described several barriers in approaching the athletes, including the athletes' denial of ED, lack of female colleagues on the team and the lack of easily accessible resources for treatment referral on both the national sports federation and the club levels.

Turk, Prentice, Chappell, & Shields (1999) reported need to validate findings from their study, to determine the actual effectiveness of education in the prevention of eating disorders, and to differentiate coaches' knowledge specific to sport and age of the athletes (Turk et al., 1999).

A number of studies in recent years, indicating that athletes who train and compete in aesthetic sports and sports with weight categories, show the problem in maintaining a certain body weight represents a serious risk for eating disorders. This problem is significantly higher than in the general population, since they have more pressure to maintain a low body weight and be thin. One of the main conditions for achieving top results in these sports is to maintain a low percentage of fat. Therefore, the willingness of athletes to reduce food and control their body weight unattended, has significantly increased. Athletes competing in aesthetic sports are at a significantly greater risk than in sports where there is no weight control. Because of all this, it is necessary during the years of the training process, which begins in early childhood, to have professional help and take doctor's advice on proper nutrition during great efforts. To prevent problems, it is necessary to include coaches and parents in the education process, to ensure proper growth and development of the child into a young person, and later in into elite athlete. Authors of scientific researches suggest that it is necessary to explore and define the role of the coach, and the importance of parents and peers when it comes to the emergence and development of eating disorders. The aim of this study is to determine coaches' knowledge about eating disorders in athletes, as part of the project "Prevention of eating disorders in young athletes in the territory of Vojvodina".

METHODS

Subjects

Twenty national coaches (6 gymnastic and 14 dance coaches) responded to the two-part questionnaire. Questionnaires were filled out anonymously. The first questionnaire examined the coaches' attitude and their willingness to work with athletes who exhibit symptoms of eating disorders. While the second survey questioned the level of information about the symptoms of eating disorders, especially anorexia and bulimia as well as misconceptions related to these disorders in athletes.

Statistical analysis

All data were analysed by descriptive statistics in SPSS 16.0. Data were analized collectively due to the small sample size. Males constituted 50 % (n = 10) and females, 50 % (n = 10) of the sample. These coaches represented two different sports, but they coached female athletes, from all age categories.

RESULTS

Results showed that 5o % of coaches have had expirience to work with the athletes with eathing disorders (Figure 1). As for the knowledge that they have (Figure 2), 80% of them believe that the knowledge that they have is satisfactory, but existing knowledge is not enought to identify the problem (50%) (Figure 3). They received the information through the professional literature and the media (80%), while a very small number of them (about 10%) based their knoledge on the experience that their colleagues had, which means that they rarely talk about it (Figure 4).

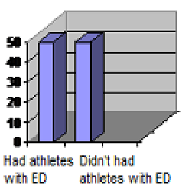

Figure 1. Percentage of coaches working with athletes with ED

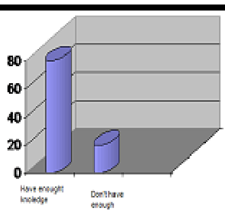

Figure 2. The answer to the question whether they have enough knowledge

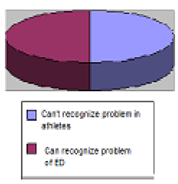

Figure 3. Percentage of the coaches that can recognize ED

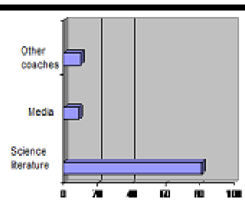

Figure 4. Informations about ED

DISCUSSION

This research is a part of a longitudinal study aimed to prevent eating disorders in female athletes in aesthetic sports. Most of the coaches agreed that the disturbances of eating is a serious problem in aesthetic sports and that they have had expirience to work with the athletes with this problems.

Questionnaire on specific knowledge has shown that they have basic information about disorders as well as the age with higher risks, but do not have a clear view on the characteristics and manifestations of the disorders. For example, they think that obese people have more psychological problems than those who do not have weight problems, and also that people who are obese can not lose weight because they "do not have sufficient will". One of the prejudices was that bulimic women are extremely skinny.

Turk et al. (1999) reported that coaches who have a high level of confidence in their knowledge but actually have a low knowledge score could pose more of a threat than an individual with a high knowledge and low confidence score. Individuals who are very confident in their level of knowledge about eating disorders may offer suggestions or tips or impose ideas about an athlete's weight, body fat, nutritional needs, or so forth. If these individuals actually have a low level of accurate knowledge about eating disorders, the information they offer may be incorrect or they may inadvertently promote harmful eating or dieting practices.

The authors propose different strategies for prevention and treatment of eating disorders (Morgado & Coelho, 2014; Sundgot-Borgen, Torstveit & Skårderud, 2004), and it is supported by transparent research with the aim to summarize the results of the published papers and propose directions for future research in this area (Sundgot-Borgen, Torstveit & Skårderud, 2004; Sundgot-borgen et al., 2013; Treasure, Cardi & Kan, 2012). Prevention of eating disorders should become a mandatory part of educational programs for coaches and athletes in all sports, because it is one of the strategies to increase knowledge about the correlates, risk factors, risk groups and strategies for early detection (Morgado & Coelho, 2014). We are still in need of longitudinal controlled large scale intervention studies examining effective intervention and prevention strategies for female athletes. Intervention programs need to be sport and sex specific. Moreover, education programs or strategies should be evaluated routinely to determine their effectiveness with respect to changing knowledge, attitudes, and behaviors (Morgado & Coelho, 2014).

CONCLUSION

This pilot study is a part of a longitudinal study with the aim of prevention of various eating disorders of gymnasts and other athletes in aesthetic sports in our country. The program will include education for trainers and athletes, monitoring programs and strategies for maintaining or losing weight in active and former female athletes, with aim to provide them necessary informations about proper nutrition, as well as other preventive treatments.

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THE HISTORY, THEORY AND PRACTICE OF RESTRICTED BLOOD FLOW RESISTANCE TRAINING (RBFRT/KAATSU)

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SUMMARY

Restricted blood flow resistance training (RBFRT/KAATSU) is a relatively new method of training that leads to positive effects in the strength gain and hypertrophy of muscle tissue such as high intensity resistance training of ≤70 % of 1RM but for much shorter period and without risks of injuries. KAATSU Training consists of performing low-intensity resistance training while a relatively light and flexible cuff is placed on the proximal part of one's lower or upper limbs, which provides appropriate superficial pressure. KAATSU Training does not induce ischemia within skeletal muscle, but rather promotes a state of blood pooling in the capillaries within the limb musculature. Applied basics and clinical research conducted over the past 15 years has demonstrated that KAATSU Training not only improves muscle mass and strength in healthy volunteers and athletes but also benefits patients with cardiovascular and orthopedic conditions, even astronauts.

Key words: KAATSU, RBFRT, restricted blood flow, occlusion, resistance training, strength, muscle mass, hypertrophy, effects.

INITIAL CONSIDERATIONS

Resistance training has long been acknowledged as an effective stimulant resulting in hypertrophy and an increase in skeletal muscle strength (American College of Sports Medicine position stand, 2009). According to ACSM recommendations, high-intensity training (≥70% 1RM) with a low number of repetitions before reaching muscle fatigue (8≤12 repetitions maximum) can lead to changes in the functional and morphological characteristics of muscular tissue in favor of hypertrophy and an increase in muscle strength (ACSM, 2009).

Higher training intensity is frequently linked with orthopedic complications (Miyachi, Kawano, Sugawara, Takahashi, Hayashi *et al.,* 2004; Roth, Martel, Ivey, Lemmer, Metter *et al.,* 2000), such as pain in the joints and lower back. During a training process which includes a method of high-intensity training (HIT), athletes run a higher risk of injury (Fry, Kraemer, Van Borselen, Lynch, Triplett *et al.,* 1994). Medium-intensity resistance training is recommended as a measure against ageing, increasing muscle strength and endurance (Nakajima, 2007).

Increases in muscle mass and strength are effects that are not easily achievable in clinical tests, since they require a prolonged period, no shorter than 2 months in duration, of high-intensity training (Roth *et al.,* 2000). However, HIT is not recommended for the elderly as it increases the risk of injury to the skeletal system, soft tissue, as well as the circulatory system. Moreover, an increase in arterial stiffness, one of the indicators for atherosclerosis, has also been found in healthy young persons following HIT (Miyachi, Donato, Yamamoto, Takahashi, Gates *et al.,* 2003; Miyachi *et al.,* 2004; Kawano, Tanaka & Miyachi, 2006).

These findings indicate that high-intensity training (≥70% 1RM) should only be administered with great care, both for athletes and for physically active people in general, and especially when it comes to developing children, the elderly (ACSM, 2009), convalescents, as well as individuals with cardiovascular diseases. Conventional training conducted with an intensity lower than 70% 1RM is considered less efficient for increasing strength and achieving muscle hypertrophy (McDonagh & Davies, 1984, Kraemer, Adams, Cafarelli, Dudley, Dooly *et al.,* 2002). For the reasons noted above, new methods of training need to be explored, ones that would have the same effect regarding strength and hypertrophy gains, yet with minimal side-effects for the human skeletal, muscular and cardiovascular systems.

Studies conducted over the last decade have demonstrated that low-intensity resistance training (LI-RT) can lead to hypertrophy and increase in the strength of skeletal muscles using only 20-30 % 1RM (Takarada, Tsuruta & Ishii, 2004; Karabulut, Abe, Sato & Bemben, 2010; Yasuda, Fujita, Ogasawara, Sato & Abe, 2010).

THE CONCEPTION OF THE IDEA OF KAATSU – RBFRT TRAINING

This training method was conceived in Japan by Professor Yoshiaki Sato who began conducting experiments in the early 1960s, first on himself and later on his patients (Sato, 2005).

"I started this training during my first year of high school after seeing a bodybuilder on TV for the first time in my life. In the fall of 1966, I had the inspiration for the KAATSU training while paying respect to the Holy Buddha at a memorial site. During the ceremony my legs went numb as a consequence of the position I was sitting in (kneeling on the floor with my back straight). I started massaging my calves and noticed a swelling and discomfort in this area, very similar to what I would feel after resistance training targeting the calf muscles. My assumption was that this feeling of swelling was caused by decreased blood flow to the muscle" (Sato, 2004a; in: Sato, 2005).

It took many experiment repetitions in order to determine the optimal position for applying pressure with the aim of decreasing blood flow to the active muscle. Applying too much pressure would result in my skin going blue and, had I continued with this line of training, thrombosis would have ensued. It is very difficult to optimally decrease blood flow to achieve positive effects. It should be emphasized that this technique ought not to be applied without a thorough knowledge of the appropriate application of the KAATSU apparatus (Sato, 2005).

THE THEORETICAL FOUNDATIONS OF THE KAATSU OR LI-BFR TRAINING METHOD

A review of literature to date yielded several terms used to refer to LI-RT, depending on the demographics of the context where the studies were conducted. The method is termed KAATSU in Japan (Sato, 2005), which translates as “additional pressure”, whereas in the Europe and US it is termed BFOT, i.e. Blood Flow Occlusion Training, or RBFRT,i.e. Restricted Blood Flow Resistance Training (Loenneke, G.J. Wilson & J.M. Wilson, 2010; Fahs, Loenneke, Rossow, Thiebaud & Bemben, 2012).

The Kaatsu method is a new resistance training method which stimulates muscle fibers and can contribute to hypertrophy and the increase in strength of skeletal muscles, even at low resistance intensity (Sato, 2004a).

The Kaatsu training method is a type of resistance training where, in the course of muscle activity, occlusion is used to decrease venous and arterial blood flow through the active extremities. A special belt or elastic band is placed on the proximal end of the extremity, the "root" of the arm or leg, and this is accompanied by a dynamic-type muscle contraction (Sato, 2004a; Loenneke *et al.*, 2010; Fahs *et al.*, 2012).

The novelty of this training method compared to other principles known to date is that this is a short-duration, low-intensity training which results in an increase in strength and muscle hypertrophy. A number of studies have so far found that one of the prerequisites for gaining muscle mass and strength is in fact functional stress, that is, mechanical stress caused by high-intensity resistance training (Fluck & Hoppeler, 2003; Goldberg, Etlinger, Goldspink & Jablecki, 1975; in: Jones & Rutherford, 1987; Baldwin, Valdez, Herrick, MacIntosh, & Roy, 1982; in: Adams & Haddad, 1996), in addition to other factors such as protein synthesis, diet, physical activity and growth factor (Sandri, 2008). By using this method, functional stress of the recruited muscle is achieved more quickly.

The advantage of the KAATSU training method in relation to methods known to date is that similar, or even better, results in terms of hypertrophy and muscle strength can be achieved more quickly using a low-intensity training method of 20%-50% 1RM.

THE PRINCIPLE OF APPLYING OCCLUSION AND TRAINING METHOD INSTRUCTIONS

A special KAATSU device or elastic band is placed around the proximal section of the extremity whose muscle we wish to stimulate. The pressure can be relatively low, as in the study by Yasuda *et al.* (2010), which demonstrated that the positive effects of this method can be achieved with an occlusion of just 30 mmHg. More frequently, however, an average pressure of 100 mmHg is used, since this is sufficient stimulant for restricting venous blood flow, resulting in blood retreating to blood vessels distal to the occlusion site, which in turn leads to arterial blood flow restriction (Moore, Burgomaster, Schofield, Gibala, Sale *et al.* 2004). One study noted positive effects after applying pressure as high as 250 mmHg (Nakajima, Kurano, Sakagami, Iida, Fukumura, *et al.* 2010). It is important to emphasize that these studies did not use constant pressure every day for the duration of the treatment. The pressure applied was varied, with its values in the lower numbers at the beginning of the treatment and rising gradually as the treatment progressed, from one practice session to another, to the maximal values noted above. The significance of such a method lies in adapting the muscle tissue to new conditions, namely the applied blood flow occlusion.

Given the nature of the KAATSU method, studies use only two regions to apply the bands – the upper and lower extremities (Takarada & Ishii 2002; Yasuda, *et al.*, 2010), with a weekly frequency of sessions ranging from 3 (Ishii, Madarame, Odagiri, Naganuma & Shinoda, 2005; Karabulut *et al.*, 2010) to 6 times per week (Yasuda, Abe, Sato, Midorikawa, Kearns *et al.* 2005; Yasuda *et al.*, 2010), and a daily frequency of up to twice daily (Abe, Beekley, Hinata, Koizumi & Sato, 2005; Yasuda *et al.,* 2005). Stress intensity compared to 1RM varied from 20 % (Abe *et al.*, 2005; Yasuda *et al.,* 2005) to 50% (Takarada & Ishii 2002), the number of sets from 3 to 5, the number of repetitions from 15 to 30, mainly until reaching muscle fatigue.

Typical low-intensity training is conducted at an intensity of 20-50 % 1RM with a duration of concentric and eccentric contractions of 2 seconds (Takada, Okita, Suga, Omokawa, Kadoguchi, *et al.,* 2012). 1 RM is calculated based on the maximal amount of weight a person can lift under normal conditions, sans blood flow restriction. Between three and five sets are done, with each exercise finishing in voluntary fatigue as a consequence of contraction. This is done to ensure a high concentration of metabolites in the engaged muscle. Rest periods between sets vary from 30 seconds (Yasuda *et al.*, 2005; Takarada & Ishii 2002; Abe *et al.*, 2005) to one minute (Karabulut *et al.*, 2010; Nakajima *et al.,* 2010; Barcelos, Nunes, de Souza, de Oliveira, Furlanetto *et al.,* 2015). The occlusion is applied for as long as the exercise is performed, regardless of the pauses between sets. The duration of exercise is between 5 and 10 minutes, depending on all the aforementioned training variables.

KAATSU TRAINING EQUIPMENT

Sato dedicated a considerable amount of time to perfecting the technique and acquiring new knowledge about the KAATSU training method, including about a dozen of his students in the process of following his work. Ten years and several thousand participating students later, the KAATSU training method was generalized for public usage in 1983. During this period, Sato came to a firm decision about working on improving the equipment (Figure 1) for achieving occlusion, to which purpose he had previously used the remnants of a common bicycle inner tube.

In December 2003, a new KAATSU training device was developed (KAATSU MASTER(tm)), providing much greater precision and pressure control for ensuring safety (Figure 2) (Sato, 2005).

Figure 1. Kaatsu cuff with pressure

Figure 2. Kaatsu training Master

KAATSU TRAINING PROJECTS IN JAPAN

Today, joint projects include collaboration with Tokyo University Technology Licensing Organization, Ltd. (CASTI); basic research on biochemical and molecular mechanisms associated with KAATSU Training (headed by Dr. Naokata Ishii of The University of Tokyo); applied research on the effect of acute KAATSU Training on muscular hypertrophy which could be used for the prevention of disability among the elderly (headed by Dr. Takashi Abe of The Tokyo Metropolitan University); animal research on the use of KAATSU Training on racehorses for injury prevention and rehabilitation (headed by Dr. Kenneth H. McKeever, Rutgers University, Equine Science Center); and medical research on the use of KAATSU Training for functional rehabilitation from cerebrovascular disorder (Dr. Yoshiharu Yokogawa, Shinshu University, School of Medicine). These projects are ongoing with many promising preliminary results being reported (Abe, Sato, Inoue, Midorikawa, Yasuda, *et al.* 2004a; Abe, Kearns, Manso, Sato, Sleeper, *et al.* 2004b; Kawada, Waga, Sato, Abe & Ishii, 2004; Yasuda, *et al.* 2005; prema: Sato, 2005).

APPLICABLE POPULATIONS

Referring to the previous experimental studies, this method has broad application value among the human population. It has been proven effective in athletes (Takarada, Sato & Ishii, 2002), in patients in the postoperative rehabilitation period, especially for patients with ACL knee injury (Takarada, Takazawa & Ishii, 2000), patients with cardiovascular disease, elderly persons (Karabulut, *et al.,* 2010); and even astronauts (Iida, Kurano, Takano, Kubota, Morita, *et al.* 2007), without difference in relation to gender.

Because occlusion training allows individuals to train at much lower intensities with the benefits of higher intensity training, it may be highly useful for other postoperative populations than ACL injuries as it had been studied (Takarada, *et al.,* 2000), and for improving muscular function in the bedridden older population. Patients who are injured, specifically ACL injuries, have been shown to benefit from an occlusive stimulus. With knee surgery, suppressing the disuse atrophy of thigh muscles has been regarded as important because the rehabilitation usually takes a prolonged period to regain the original muscular strength. Takarada, *et al.* (2000) showed that when an occlusion was present even without an exercise stimulus, it was effective in diminishing the disuse atrophy of knee extensor 3 days after surgical operation.

KAATSU may also be useful in the cardiac rehabilitation setting because occlusion has been shown to significantly stimulate the exercise-induced GH, IGF, and vascular endothelial growth factor (VEGF) responses with the reduction of cardiac preload during exercise (Takano, Morita, Iida, Asada, Kato, *et al.* 2005). GH and IGF-1 have been established as regulators of cardiac growth, structure, and function, and GH has been applied for treatment of congestive heart failure (Khan, Sane, Wannenburg & Sonntag, 2002). There is a wide spectrum of KAATSU training studies in wich have been found to have positive effects on elderly, when it comes to increasing the strength, hypertrophy of muscle tissue (Nakajima, *et al.* 2010; Karabulut, *et al.,* 2010, Abe, *et al.,* 2005), and post occlusive blood flow for both sex (Patterson & Ferguson, 2011).

Astronauts are also a unique population that could benefit from occlusion training. During spaceflight, several health concerns arise due to the changes in cardiovascular function that occur due to weightlessness. When gravitationa hydrostatic gradients are abolished, there is a shift of intravascular fluid from the capacitance vessels of the legs and lower body centrally toward the head. Elevations of capillary blood pressure and increased capillary perfusion pressure in tissues of the head have been shown to cause facial intracranial edema and headache. On return to Earth, orthostatic intolerance is the most serious symptom of cardiovascular deconditioning; in addition, significantly reduced exercise capacities and increased resting heart rate are also observed regardless of the duration (Blomqvist, Buckey, Gaffney, Lane, Levine, *et al.* 1994; Buckey, Lane, Levine, Watenpaugh, Wright, *et al,* 1996; prema: Iida, *et al.* 2007). Almost every astronaut after the space flight experiences orthostatic hypotension and reduced upright exercise capacity, which is likely attributed to the microgravity-induced hypovolemia, decreased baroreflex responsiveness, decreased skeletal muscle tone, and increased venous compliance. When occlusion has been applied on both thighs in supine subjects, it induced the hemodynamic, hormonal, and autonomic alterations that were very similar to standing. Ilda et al. conclude that occlusion training may be a promising and safe method to counter symptoms of orthostatic intolerance and muscle atrophy in astronauts (Iida, *et al.* 2007).

IN LIEU OF A CONCLUSION

RBFRT/KAATSU is a new method of training which has not yet been studied in depth in this part of the world. This method has great training potential in terms of developing strength and muscle hypertrophy in different populations. I believe that further empirical studies on different populations are needed in order to fully explore the claims about the positive effects of this method on the development of desired functional abilities.

The characteristics of KAATSU training are as follows:

- Short-term and low-intensity loads;
- KAATSU training with high-intensity loads has little effect, but it may be rather dangerous. Needless to say, restricting blood flow for a long time should be avoided.
- Hemostasis with a tourniquet should be avoided;
- KAATSU training should, in principle, be conducted by KAATSU trainers and instructors;
- This is believed to be one of the reasons why serious complications have been seldom occurred until now.

- It is said that over 200,000 people are currently conducting KAATSU training to improve the muscle strength of able-bodied people, sportsmen and older people, and for health maintenance purposes (Nakajima, Morita & Sato, 2011).
- Main side effects include petechial hemorrhage beneath the skin which is caused by applied pressure and disappears after a few days of application, chills, numbness, and dizziness (Nakajima, *et al.,* 2011).
- There are also now hopes that it can be applied to the rehabilitation of patients with a variety of diseases (Sato *et al.,* 2007;) which is proven to be reality (Iida, *et al.* 2007; Takano, *et al*. 2005; Takarada, *et al.,* 2000; Karabulut, *et al.,* 2010).

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USE OF ULTRASOUND DIAGNOSIS IN THE FOLLOW-UP OF EFFECTS OF RESISTANCE TRAINING

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SUMMARY

It is highly probable that individual variations of hypertrophic adaptive response, related to the resistance training intensity, are the consequences of different muscle morphology. Measurements of muscle quality have been increasingly used in the last decade as non-invasive methods to assess muscle characteristics and muscle strength. The parameters of muscle architecture, such as cross-sectional area, muscle thickness, fascicle length, and pennation angle are the determinants of muscle function in human movement that can be evaluated using ultrasound. Ultrasound measurements of individual skeletal muscles are characterized by high reliability and reproducibility, they are relatively cheap and can be performed in a short period of time. The studies and meta-anylyses have demonstrated that ultrasound assays are characterized by a high degree of correlation with MRI and CT findings in the measurement of skeletal muscle cross-sectional area. Further, some recent studies have suggested a high degree of correlation between ultrasound assessment of quality with exerted strength of individual skeletal muscles.

Keywords: hypertrophy, skeletal muscle, resistance training, ultrasound.

INTRODUCTION

Hypertrophy represents organ or organ part enlargement caused by enlargement of the constituent cells. Skeletal muscle tissue is characterized by a high degree of plasticity and easily adapts to acute or chronic higher demands. Increased muscle strength represents the primary stimulus for the onset of skeletal muscle enlargement (hypertrophy) during resistance training (Schoenfeld, 2013). Earlier studies have clearly indicated that when subjected to functional overload, muscle tissue responds with increasing its own cross-sectional area. Although hypertrophy occurs in all types of skeletal muscle fibers, fast twitch fibers demonstrate about 50% higher growth capacity compared to slow twitch fibers. Moreover, there is a high degree of individual variability in the range of adaptive hypertrophic response throughout the whole spectrum of different subtypes of skeletal muscle fibers (Fluck & Hoppeler, 2003; Adams & Bamman, 2012). The three basic factors that mediate hypertrophy as an adaptive response to resistance training are: mechanical load (stress), metabolic stress, and muscle damage. Mechanical load (stress) of the components of the muscular system initiates signal proteins which subsequently activate the genes responsible for protein synthesis stimulation. The results of previous studies have shown that mechanical strain is the principal driving force in the process, after which increased protein synthesis leads to increased muscle mass (Radovanović & Ignjatović, 2009). This relationship of causes and consequences represents the fundamental biological adaptation of an organism to physical activity with increasing load, independent of age and gender. However, under the assumption that a given level of mechanical strain has been reached, metabolic stress and tissue damage are the essential factors in hypertrophic response optimization. Up to the present time, there has been no convincing evidence of possible predominance of any of the concrete parameters in the activation of cellular and molecular mechanisms responsible for regulation of muscle cell growth.

MUSCLE HYPERTROPHY DURING RESISTANCE TRAINING

From both the theoretical and practical points of view, when resistance training is concerned, it is thought that concentric contractions, with the intersity exceeding 60% of the value of one repetition maximum, are the necessary pre-requisite for muscle hypertrophy (Fluck & Hoppeler, 2003; Adams & Bamman, 2012). Targeted studies have demonstrated that the average number of repetitions (6-12) with a controlled rhythm of external load increase, can be an adequate stimulus for maximum muscle hypertrophy (Fry, 2004; Hulmi, Walker, Ahtiainen, Nyman, Kraemer & Hakkinen, K. 2012), although the available evidence is far from convincing. This so called ”scope of hypertrophy” probably provides an optimal combination of mechanical strain, metabolic stress and muscle damage, creating thus a sustainable anabolic response to maximize muscle protein accumulation (Schoenfeld, 2010). A lower number of repetitions (1-5) allows for the use of larger loads and thence greater mechanical strain. In contrast to that, a higher number of repetitions (15+) can be helpful in reducing the rise of training-induced lactates (Harber, Fry, Rubin, Smith & Weiss, 2004); therefore, delaying the onset of fatigue, this could lead to greater fiber engagement. Such an approach can be important especially for persons with longer training experience, in whom a higher degree of overload is necessary for continued adaptation.

It is highly probable that individual variations of hypertrophic adaptive response, related to the resistance training intensity, are the consequences of different muscle morphology. There is clear evidence that among men and women huge variations can be demonstrated in their response to the same resistance training protocol, and within the same gender in some examinees a slight increase of muscle mass has been reported, while in the rest the increase has been clearly visible (Hubal, Gordish-Dressman, Thompson, Price, Hoffman, Angelopoulos, et al., 2005; Bamman, Petrella, Kim, Mayhew & Cross, 2007). These variations can be explained, at least partly, by the differences in distibution of various types of muscle fibers. Studies have demonstrated a high genetic interindividual variability in the percentage of fast twitching compared to slow twitching fibers in a specific muscle (Simoneau & Bouchard, 1995) and these relationships can result in different responses to the same training program (Costa, Breitenfeld, Silva, Pereira, Izquierdo & Marques, 2012). All of the above findings suggest the possibility that an adaptation to low and high resistance training intensity can be specific related to the fiber type composition of an individual muscle. For instance, there has been evidence that *m. soleus*, due to a higher percentage of slow twitching fibers, is characterized by a much weaker hypertrophic reaction to traditional resistance training compared to *vastus lateralis m. quadriceps femoris* or *m. biceps brachii*, characterized by a higher proportion of fast twitching fibers. The process of hypertrophy directly increases the synthesis of cellular structures, with a special impact on the composition of proteins that make up contractile elements. Strenuous training programs have an impact on the increase of messenger ribonucleic acid (mRNA) translation process and stimulate myofibrillar protein synthesis (Mikesky, Giddings, Matthews & Gonyea, 1991). As already stated, skeletal muscle enlargement can be the result of repeated damage to the muscle tissue (especially in eccentric contractions), followed by compensatorily increased protein synthesis, leading to an anabolic effect (Kjaer, 2004). Myofibrils thicken and their number grows, and due to enhanced protein synthesis additional sarcomeres are formed (Mikesky et al., 1991). Additionally, anaerobic energy sources (adenosine triphosphate, creatine phosphate, and glycogen) are markedly elevated in the muscle cells, which leads to elevated and quicker energy release during strenuous training sessions (Radovanović & Ignjatović, 2009). Although muscle fibers during resistance training in prolonged periods of time react in a manner that the amount of contractile proteins within them is increased in parallel to the energy-generating components, the number of capillaries, total volume of the mitochondria, and their enzymes do not follow this increase. On the account of that, the relationship of concentration of myofibrillary (contractile) proteins with mitochondria, i.e. mitochondrial enzymes, is disturbed to the advantage of the former (Kjaer, 2004). However, such an adaptive response of the organism to resistance training does not impede the exertion of muscle strength and power in short-term activities (a jump, hit, sprint, etc.) due to their anaerobic nature (Radovanović & Ignjatović, 2009).

ULTRASOUND EVALUATION OF HYPERTROPHIC CHANGES OF THE SKELETAL MUSCLES

Measurements of muscle quality (MQ) have been increasingly used in the last decade as non-invasive methods to assess muscle characteristics and muscle strength (Goodpaster, 2001; Fukumoto, Ikezoe, Yamada, Tsukagoshi, Nakamura, Mori & Ichihashi, 2011). MRI and CT technologies have been used to quantify the cross-sectional area (CSA) of the skeletal muscle, to evaluate the relation of intramuscular fat and connective tissue, which taken together produce muscle quality assessment, However, these machines are rather expensive and utilize special algorithms for tissue quantification. Some recent studies have demonstrated that ultrasound assays are characterized by a high degree of correlation with MRI and CT findings in the measurement of skeletal muscle CSA (Ahtiainen, Hoffren, Hulmi, Pietikäinen, Mero, Avela & Häkkinen, 2010; Mendis, Wilson, Stanton, Hides, 2010). The parameters of muscle architecture, such as cross-sectional area, muscle thickness, fascicle length, and pennation angle are the determinants of muscle function in human movement that can be evaluated using ultrasound. Pennation angle is an angle of muscle position related to muscle fiber position. Cross-sectional area (Ikai & Fukunaga, 1968) and muscle thickness (Freilich, Kirsner & Byrne, 1995) are related to muscle strength, while fascicle length is related to maximum contraction velocity (Bodine, Roy, Meadows, Zernicke, Sacks, Fournier & Edgerton, 1982) and length–tension curve (Burkholder, Fingado, Baron & Lieber, 1994). Moreover, the pennation angle is associated with the efficacy of force transmission from muscle fibers to the tendon (Alexander & Vernon, 1975).

One of the principal elements in ultrasound assessment of muscle quality is the measurement of echo-intensity, which directly depends on the amount of fatty tissue and conntective tissue infiltration within a muscle. Therefore, in individuals with excess body weight and in obese ones, an increase of echo-intensity and reduction of assessed muscle quality can be encountered (Miljkovic & Zmuda 2010; Nijboer-Oosterveld, Van Alfen & Pillen, 2011). Furthermore, numerous factors such as gender, race, level of physical fitness and body composition influence the reliability of echo-intensity in the measurement of cross-sectional area (Melvin, Smith-Ryan, Wingfield, Fultz & Roelofs, 2014). Nevertheless, the studies and meta-anylyses published so far have provided evidence that ultrasound is a solid, reliable method for the measurement of cross-sectional area in healthy subjects (Bemben, 2002; Ahtiainen et al., 2010; Mendis et al. 2010; English, Fisher & Thoirs, 2012). Ultrasound measurements of the thickness of *m. quadriceps femoris* are characterized by rather good reliability and reproducibility (English et al., 2012), can be performed in a relatively short period of time, and have a high degree of correlation with the exerted strength of *m. quadriceps femoris* (Strasser, Draskovits, Praschak, Quittan, & Graf, 2013). Besides, it has been shown that ultrasound measurements of *m. rectus femoris* thickness have a high degree of correlation with similar measurements using the MRI technique (Thomaes, Thomis, Onkelinx, Coudyzer, Cornelissen & Vanhees, 2012).

Several studies have reported that resistance training leads to changes in the parameters of muscle architecture (Aagaard, P., Andersen, Dyhre-Poulsen, Leffers, Wagner, Magnusson, Halkjaer-Kristensen & Simonsen, 2001; Kawakami, Abe, Kanehisa & Fukunaga, 2006; Blazevich, Cannavan, Coleman, Horne, 2007; Seynnes, de Boer & Narici, 2007; Erskine, Jones, Williams, Stewart & Degens, 2010 a, b). Kawakami, Abe, Kuno & Fukunaga (1995) have shown that after resistance training increased have been both muscle thickness and pennation angle of *m. triceps brachii*. On the other hand, there have been certain differences regarding the existance of changes in the parameters of muscle architecture of *m. quadriceps femoris* after resistance training. Aagaard et al. (*2001*) have demonstrated an increased pennation angle of *vastus lateralis* (VL) after 14 weeks of resistance training, while other similar studies (Rutherford & Jones, 1992; Alegre, Jimenez, Gonzalo-Orden, Martin-Acero & Aguado, 2006) have not been able to establish any changes either in VL, or in other three muscles: *vastus medialis*, *vastus intermedius*, and *rectus femoris* (Erskine et al. 2010b). Futhermore, some earlier studies have reported an increase in facsicle length in VL (Blazevich et al., 2007; Seynnes et al., 2007) after resistance training, while in others the effect has not been observed (Seynnes et al., 2009; Erskine et al., 2010a). The studies mentioned here indicate that there is no consensus regarding the changes of muscle architecture parameters of *m. quadriceps femoris* after resistance training (Ema, Wakahara, Miyamoto, Kanehisa & Kawakami, 2013), which poses a serious problem bearing in mind the significance of this muscle both in everyday activities (Takai, Ohta, Akagi, Kanehisa, Kawakami & Fukunaga, 2009) and in sports activities (Thorpe, Li, Crompton & Alexander, 1998).

CONCLUSION

Ultrasound measurements of individual skeletal muscles are characterized by high reliability and reproducibility, they are relatively cheap and can be performed in a short period of time. Further, some recent studies have suggested a high degree of correlation between ultrasound assessment of quality with exerted strength of individual skeletal muscles. Differences in the magnitude of muscle hypertrophy between the studies are probably the consequence of different results of the measurement of muscle architecture parameters after resistance training. Results of the studies published so far have indicated that muscle hypertrophy is associated with altered pennation angle, but not always with increased fascicle length, and they have also indicated the presence of non-homogenous hypertrophic changes within a single muscle and among the muscles with several heads.

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EXPERIMENTAL COMPARATION OF DIFFERENT ORTHOGONAL ROTATIONS IN EXPLORATORY FACTOR ANALYSIS

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SUMMARY

The main goal of this study was to make experimental comparation of factor structure matrices generated trough different ofthogonal rotations while applying exploratory strategy of factor analysis. The research was conducted on the sample of 239 healty pupils aged 8-10 years. Variables with well known latent structure: body height, body weight, forearm circumference, upper arm skin fold, side steps, polygon backwards, standing on the bench, straddle forward bend, hand-tapping, long jump from a standstill, sit-ups and held part in the hang were measured. Orthogonal rotations: *varimax raw*, *varimax normalized*, *biquartimax raw*, *biquartimax normalized*, *quartimax raw*, *quartimax normalized*, *equamax raw* and *equamax normalized* rotations were applied and their factor structures were discussed and compared. Results are pointing to the fact that usage of different orthogonal rotations probably will, generate very similar factor stucture matrix. In accordance with obtained results, it is obvious that scientist or researcher in field of kinesiology, but also in general, can choose between various orthogonal rotating options probably without possibilty that his selection have impact on the generated latent structure.

Keywords: methodology, latent structure, similarity of solutions

INTRODUCTION

Exploratory Factor Analysis (EFA) is multivariate mathematical technique unavoidably used in scientific researches (Loehlin, 2003; Trninić, Jelaska, & Štalec, 2011, 2012). Although often considered as statistical technique it is a set of algorithms which goal is to detect dimensionality of observed structure (Borsboom, Mellenbergh, & Van Heerden, 2003). As it is well known, factor analysis is performed by exploring the pattern of correlations (or covariances) between the observed measures (Costello, & Osborne, 2005; Jelaska, Mandić Jelaska, & Lovrić, 2012). It is assumed that variables that are highly correlated are probably influenced by the same latent constructs or latent dimensions or factors. Contrary, those variables that are uncorrelated are very likely influenced by different underlying factors (Jelaska, Mandić Jelaska, & Lovrić, 2012). After caractheristic equation is solved (i.e. eingenvalues are calculated), by some criterion (GK, Scree, PB,...) number of „significant" latent dimensions is determined (Zwick, & Velicer, 1986; Hayton, Allen, & Scarpello, 2004). Choosing of appropriate rotation is due to identification of simple structure (Cudeck, & MacCallum, 2007). Ideal simple structure is achieved if any given observed variable has a high loading on a single factor and approximately 0 loadings on the remaining factors and if any given factor is made by a few variables with very high loadings on this factor while the remaining variables have approximately 0 loadings on this factor (Trninić, Jelaska, & Štalec, 2012). Rotation can be orthogonal or oblique. Orthogonality condition simply means that rotation is „sub-space invariant" (Hox, & Roberts, 2010). Most used orthogonal rotation, *Varimax* is so called because of it's mathematical property of maximization of the sum of the squared correlations between variables and factors. If these conditions hold, the factor loading matrix is said to have "simple structure," and varimax rotation brings the loading matrix closer to such simple structure (as much as the data allow) (Wood, Tatryn, & Gorsuch, 1996). From the perspective of single individual who has been measured on the variables, varimax rotation seeks a sub space of independent vectors that can describe him most accurate by its linear combination (Velicer, Eaton, & Fava, 2000). There is a lack of scientific research dealing with effects of applying of different oblique or orthogonal rotations. In accordance with that, the main goal of this study is to make experimental comparation of factor structure matrices generated trough different orthogonal rotations while applying exploratory strategy of factor analysis.

METHODS

Subjects

The research was conducted on the sample of 239 healty pupils aged 7-10 years.

Sample of variables

The sample of variables used in this research were 4 standard anthropometric measures and 8 standard variables of motor status: body height (AVIS), body weight (ATM), forearm circumference (AOP), upper arm skin fold (ANN), side steps (MKUS), polygon backwards (MPOL), standing on the bench (MP20), straddle forward bend (MPRR), hand-tapping (MTAP), long jump from a standstill (MSDM), sit-ups (MDTR) and held part in the hang (MVIS). All the measurements were done by qualified people who were experience in collecting anthropometric data.

Statistical analysis

For all variables basic descriptive parameters were calculated: arithmetic mean (M), standard deviation (SD), minimum (min) and maximum (max) result, and the asymmetry (skewness) and the curvature (kurtosis) of the results distribution. Kolmogorov Smirnov test was used to test distribution normality. Factor analysis was applied by using GK criterion. Orthogonal rotations: *varimax raw*, *varimax normalized*, *biquartimax raw*, *biquartimax normalized*, *quartimax raw*, *quartimax normalized*, *equamax raw* and *equamax normalized* rotations were applied and their factor structures were presented. Absolute and relative amount of variablity explained by each factor after rotation was also calculated. All calculations were done by use Statistica 12.0 software (StatSoft, Tulsa, USA).

RESULTS

In table 1 parameters of descriptive statistics are presented together with normality testing by using Kolmogorov Smirnov test.

Table 1. Descriptive parameters: Mean(M), Standard deviation (SD), Skewness (Skew), Kurtosis (Kurt), Minimum (Min) and Maximum (Max), significance of normality testing using Kolmogorov Smirnov test (KS-p).

	Mean	SD	Skew	Kurt	Min	Max	KS-p
AVIS	1364.73	82.95	0.10	-0.16	1170.00	1600.00	p>.20
ATM	321.49	68.23	1.21	2.82	186.00	655.00	p<.01
AOP	197.23	16.52	0.50	0.43	160.00	255.00	p>.20
ANN	12.35	4.80	0.94	0.51	5.00	29.00	p<.01
ATV	156.78	35.40	3.79	22.41	100.00	444.00	p<.01
ATT	218.56	73.78	1.36	2.76	100.00	580.00	p<.01
AOP	64.80	29.16	-0.60	-1.23	6.00	90.00	p<.01
ANN	53.38	17.71	0.08	-1.21	15.00	80.00	p<.01
MKUS	22.49	4.24	0.94	3.13	11.00	43.00	p>.20
MPOL	130.41	26.77	0.04	-0.21	65.00	200.00	p<.20
MP20	25.01	8.91	-0.33	-0.34	0.00	46.00	p>.20
MPRR	28.73	26.08	1.85	3.53	0.00	120.00	p<.01

Legend: Body height (AVIS), body weight (ATM), forearm circumference (AOP), upper arm skin fold (ANN), side steps (MKUS), polygon backwards (MPOL), standing on the bench (MP20), straddle forward bend (MPRR), hand-tapping (MTAP), long jump from a standstill (MSDM), sit-ups (MDTR) and held part in the hang (MVIS).

Table 2. Factor structure matrix, amount of variability explained with factor (Expl Var), relative amount of variability explained with factor (Prop Totl).

	Varimax Raw				Varimax Normalized			
AVIS	0.80	0.32	-0.10	0.04	0.79	0.34	0.10	0.02
ATM	0.95	0.02	-0.04	-0.03	0.95	0.04	0.03	-0.04
AOP	0.92	0.01	-0.04	0.01	0.92	0.04	0.04	-0.00
ANN	0.69	-0.50	0.00	0.02	0.70	-0.48	0.01	0.02
ATV	-0.05	-0.11	0.34	-0.71	-0.05	-0.12	-0.43	-0.66
ATT	0.14	-0.68	0.30	-0.27	0.15	-0.68	-0.32	-0.22
AOP	-0.06	-0.00	0.22	0.65	-0.05	0.00	-0.14	0.67
ANN	0.11	-0.00	-0.89	0.01	0.11	0.01	0.89	-0.10
MKUS	0.21	0.46	0.05	0.44	0.20	0.47	-0.00	0.43
MPOL	0.22	0.79	0.13	0.01	0.20	0.79	-0.14	0.01
MP20	0.03	0.66	-0.06	0.08	0.01	0.66	0.06	0.07
MPRR	-0.07	0.46	0.25	0.51	-0.08	0.46	-0.19	0.53
Expl Var	3.00	2.29	1.15	1.46	2.99	2.32	1.16	1.42
Prop Totl	0.25	0.19	0.10	0.12	0.25	0.19	0.10	0.12

Legend: Body height (AVIS), body weight (ATM), forearm circumference (AOP), upper arm skin fold (ANN), side steps (MKUS), polygon backwards (MPOL), standing on the bench (MP20), straddle forward bend (MPRR), hand-tapping (MTAP), long jump from a standstill (MSDM), sit-ups (MDTR) and held part in the hang (MVIS).

In tables 2-5 factor structres are presented of orthogonal rotations: *varimax raw* and *varimax normalized* (table 2), *biquartimax raw* and *biquartimax normalized* (table 3), *quartimax raw* and *quartimax normalized* (table 4), and last *equamax raw* and *equamax normalized* (table 5).

Table 3. Factor structure matrix, amount of variability explained with factor (Expl Var), relative amount of variability explained with factor (Prop Totl).

	Biquartimax Raw				Biquartimax Normalized			
AVIS	0.80	0.32	-0.10	0.03	0.79	0.34	0.10	-0.00
ATM	0.95	0.01	-0.03	-0.03	0.95	0.04	0.03	0.04
AOP	0.92	0.01	-0.04	0.01	0.92	0.04	0.04	0.00
ANN	0.69	-0.50	0.00	0.03	0.70	-0.48	0.01	-0.04
ATV	-0.05	-0.14	0.34	-0.70	-0.05	-0.15	-0.42	0.66
ATT	0.13	-0.69	0.30	-0.25	0.15	-0.69	-0.32	0.20
AOP	-0.06	0.02	0.22	0.65	-0.05	0.03	-0.14	-0.67
ANN	0.12	0.00	-0.89	0.01	0.12	0.02	0.89	0.10
MKUS	0.21	0.48	0.06	0.42	0.20	0.49	-0.01	-0.41
MPOL	0.22	0.79	0.14	-0.02	0.20	0.79	-0.15	0.02
MP20	0.03	0.66	-0.05	0.06	0.01	0.66	0.05	-0.04
MPRR	-0.07	0.48	0.25	0.50	-0.08	0.48	-0.20	-0.52
Expl Var	3.00	2.35	1.15	1.40	2.99	2.38	1.16	1.37
Prop Totl	0.25	0.20	0.10	0.12	0.25	0.20	0.10	0.11

Legend: Body height (AVIS), body weight (ATM), forearm circumference (AOP), upper arm skin fold (ANN), side steps (MKUS), polygon backwards (MPOL), standing on the bench (MP20), straddle forward bend (MPRR), hand-tapping (MTAP), long jump from a standstill (MSDM), sit-ups (MDTR) and held part in the hang (MVIS).

Table 4. Factor structure matrix, amount of variability explained with factor (Expl Var), relative amount of variability explained with factor (Prop Totl).

	Quartimax Raw				Quartimax Normalized			
AVIS	0.80	0.32	-0.09	0.01	0.79	0.35	0.09	0.01
ATM	0.95	0.01	-0.02	-0.03	0.95	0.04	0.02	0.04
AOP	0.92	0.01	-0.03	0.01	0.92	0.04	0.03	0.00
ANN	0.69	-0.50	0.01	0.05	0.71	-0.47	0.01	-0.06
ATV	-0.06	-0.17	0.34	-0.70	-0.06	-0.19	-0.42	0.65
ATT	0.13	-0.70	0.30	-0.22	0.15	-0.70	-0.31	0.17
AOP	-0.06	0.05	0.22	0.65	-0.05	0.06	-0.14	-0.67
ANN	0.12	0.00	-0.89	0.02	0.12	0.02	0.89	0.09
MKUS	0.21	0.49	0.06	0.40	0.20	0.51	-0.02	-0.39
MPOL	0.22	0.78	0.14	-0.05	0.20	0.79	-0.16	0.06
MP20	0.03	0.66	-0.05	0.03	0.01	0.66	0.05	-0.01
MPRR	-0.07	0.50	0.25	0.47	-0.08	0.51	-0.20	-0.49
Expl Var	3.00	2.41	1.14	1.34	3.00	2.45	1.15	1.30
Prop Totl	0.25	0.20	0.10	0.11	0.25	0.20	0.10	0.11

Legend: Body height (AVIS), body weight (ATM), forearm circumference (AOP), upper arm skin fold (ANN), side steps (MKUS), polygon backwards (MPOL), standing on the bench (MP20), straddle forward bend (MPRR), hand-tapping (MTAP), long jump from a standstill (MSDM), sit-ups (MDTR) and held part in the hang (MVIS).

Table 5. Factor structure matrix, amount of variability explained with factor (Expl Var), relative amount of variability explained with factor (Prop Totl).

	Equamax Raw				Equamax Normalized			
AVIS	0.80	0.32	-0.09	0.01	0.79	0.35	0.09	0.01
ATM	0.95	0.01	-0.02	-0.03	0.95	0.04	0.02	0.04
AOP	0.92	0.01	-0.03	0.01	0.92	0.04	0.03	0.00
ANN	0.69	-0.50	0.01	0.05	0.71	-0.47	0.01	-0.06
ATV	-0.06	-0.17	0.34	-0.70	-0.06	-0.19	-0.42	0.65
ATT	0.13	-0.70	0.30	-0.22	0.15	-0.70	-0.31	0.17
AOP	-0.06	0.05	0.22	0.65	-0.05	0.06	-0.14	-0.67
ANN	0.12	0.00	-0.89	0.02	0.12	0.02	0.89	0.09
MKUS	0.21	0.49	0.06	0.40	0.20	0.51	-0.02	-0.39
MPOL	0.22	0.78	0.14	-0.05	0.20	0.79	-0.16	0.06
MP20	0.03	0.66	-0.05	0.03	0.01	0.66	0.05	-0.01
MPRR	-0.07	0.50	0.25	0.47	-0.08	0.51	-0.20	-0.49
Expl Var	3.00	2.41	1.14	1.34	3.00	2.45	1.15	1.30
Prop Totl	0.25	0.20	0.10	0.11	0.25	0.20	0.10	0.11

Legend: Body height (AVIS), body weight (ATM), forearm circumference (AOP), upper arm skin fold (ANN), side steps (MKUS), polygon backwards (MPOL), standing on the bench (MP20), straddle forward bend (MPRR), hand-tapping (MTAP), long jump from a standstill (MSDM), sit-ups (MDTR) and held part in the hang (MVIS).

DISCUSSION

From Table 1 it can be seen that normality of the variables is voilated, but it is obviously due to the sensitivity of Kolmogorov Smirnov test on rejecting null hypothesis when used sample is big. On the other size, measures of shape and curvature of distribution clearly indicate that all variables are approximately normally distributed. From tables 2-5 it can be seen that factor structure matrices are very similar and generated simple structure is the same comparing it among all applied orthogonal rotations: *varimax raw*, *varimax normalized*, *biquartimax raw*, *biquartimax normalized*, *quartimax raw*, *quartimax normalized*, *equamax raw* and *equamax normalized*. Also it is interesting that amount of variability explained with each generated factor and relative amount of variability explained with each generated factor are almost the same for all applied rotations. That fact is also clearly pointing to the fact of existence of small differences when different orthogonal rotations are applied.

CONCLUSION

Results are clearly pointing to the fact that usage of different orthogonal rotations probably will generate very similar latent structures seen trough factor structure matrix. In accordance with obtained results, it is obvious that scientist or researcher in field of sport science, physical education and kinesiology, but also in general, can choose between various rotating options probably without possibilty that his selection will impact on the generated latent structure. Further research should include comparation of orthogonal and oblique solutions on data samples of different sizes.

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POLICE ACADEMY FEMALE STUDENTS MORPHOLOGICAL CHANGES[1]

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SUMMARY

The aim of this study was to determine the existence of changing in the body structure indicators during the tree years of studies for female students of Police Academy. The sample was comprised of 20 respondents. Measurement of morphological characteristics was carried out twice, the first at the beginning of the first year of studies and second at the end of the third year. Morphological characteristics were determined by a standardized method of multichannel bioelectrical impedance - InBody 720. The following variables were monitored: body height (BH), body mass (BM), body mass index (BMI), body fat mass (BFM), skeletal muscle mass (SMM) and percentage of body fat (PBF). The results were analyzed by descriptive statistical procedures and univariate analysis of variance (ANOVA). The level of significance was at the level of 95%, respectively, $p \leq 0.05$. ANOVA showed no statistically significant differences. The results between two measurements obtained by descriptive statistics showed relative increase for variables BH by 0.09 %, BM by 1.90 % and BMI by 1.76 %. Also, from the results of descriptive statistics could be seen that for the variables BFM and PBF there was the decrease of 1.93 % and 3.28 %, while for variable SMM there was incrise of 2.95 %. Bodyweight gain in respondents was achieved by reducing the BFM and increase of SMM so we can conclude that the process of changing in body composition occurs in a positive direction. It could be concluded that for monitoring of morphological characteristics changes at individual level, longitudinal character researches can have a significant role.

Keywords: Morphology, Police Students, Female

INTRODUCTION

Human morphological composition is an important area of research in medical, social sciences and humanities (Janković i sar., 2008; Dopsaj i sar., 2009), as well as in the sciences of sport and physical education (Singh et al., 2010; Meckel et al., 2011). Actual research trends increasingly highlights importance and suggests the need for systematic monitoring of changes in morphological composition in sports, but also in the population that is engaged in recreational physical activities (Malina, 2007). Such trend also meets in researches which deal with the morphological characteristics of women working in the police (Stating et al., 2010; Dimitrijević i sar., 2012; Dopsaj i Dimitrijević, 2013; Dimitrijević i sar., 2013).

Previous scientific practice of morphological characteristics monitoring was primarily based on adipose tissue components observation, the calculation of body mass index (BMI), different parts of the body skin fold measurements, waist circumference, calculation of waist-to-hip ratio etc. (Dimitrijević i sar., 2012). BMI is the ratio between body height and body weight, the simplest and most commonly used method for assessment of the body status of the observed population or samples. However, this morphological measure does not provide insight into the interrelations of structural components, such as the distribution of total fat or fat distribution in some segments of the body, which can have great variations within normal range of body mass index (Akpinar et al., 2007).

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The new body structure measuring technology, by method of multichannel bioelectric impedance, enable precise and detailed insight into the morphological space (Hung, 2011). Unlike the so far indirect methods used, new method has the advantage of direct measurement, a small measurement error and high accuracy of the measured components (InBody 720, 2005). Systematic monitoring of the morphological characteristics is today, in accordance with modern technology, easy, fast, reliable, repeatable and noninvasive (Sudarov i Fratić, 2010).

Body dimensions affect the manifestation of force and power (Nedeljkovic et al. 2009), which are significant physical abilities in the selection and police performance. In contrast to the martial arts where opponents are divided in weight categories, solving the conflict situations in police affairs does not respect differences in anthropometric and morphological indicators. Results of the researches that have been engaged with anthropometric characteristics and their influence on the performance of police officers, shows that in the selection process there is the need to choose high and strong candidates (Jamnik et al., 2010).

The body mass increase, based on the expense of fat components, may lead to increased risk for the health status, reduction of the basic motor abilities level that contribute to the reduction of police officers professional and working efficiency (Dopsaj i sar., 2009; Glaner et al., 2010). **C**ontinuous monitoring of changes in the morphological characteristics, provide the conditions for the early prevention, regulation of processes and procedures to correct dietary habits, and also for defining appropriate workout programs models (Okecka-Szymanski et al. , 2011). In the area of morphology among police officers of different specialties, in contrast to the most developed foreign countries where it is the standard in relation to the scientific methodology and applied researches in the police, for the Republic of Serbia there is still no comprehensive researches. It is therefore necessary to determine the specifics of certain morphological characteristics in relation to all police officers in the Republic of Serbia, and also, it is necessary to define the appropriate criteria and standards for the assessment of body composition and physical appearance of the Academy of Criminalistic and Police Studies (ACPS) female students as future executive staff. Part of standards refers to the morphologic indicators, or body mass and body composition of police officers, as they represents physical characteristics most vulnerable to negative tendencies of changes in relation to the way of life (Jamnik et al., 2010; Okecka-Szymanski et al., 2011).

In our country, mostly were conducted researches with transversal character in relation to the ACPS female students population (Janković i sar., 2008; Dopsaj i sar., 2009; Dimitrijević i sar., 2012 ; Dopsaj i Dimitrijevic, 2013; Dimitrijević i sar., 2013). The results of these studies suggest that in ACPS female students there is a decreasing trend of BMI in a function of year of study. However, these results should be taken with caution and reserve, considering that in the transversal researches there is the influence of more selection processes. Based on the longitudinal monitoring, the aim of this study was to determine the existence of changing in the values of BMI, amount of muscle and fat tissue.

METHODS

Subjects

The study sample was comprised of 20 ACPS basic academic studies female students which were in a regular teaching process. All the respondents were healthy, with no acute and chronic diseases as well as with no other interference that would affect the testing results.

Procedure

Measurement of morphological characteristics was carried out twice. The first measurement was carried out at the beginning of the first year of basic studies. The second measurement was carried out at the end of the third year, after completed curriculum of Specialized Physical Education. In both measurements, morphological characteristics were determined by a standardized method of multichannel bioelectrical impedance (Bioelectrical Impedance Analysis - BIA), the professional appliance of the latest generation - InBody 720 Tetrapolar 8-Point Tactile Electrode System (Biospace, Co., Ltd.), which uses a DSM-BIA method (Direct Segmental Multi-frequency Bioelectrical Impedance Analysis) (Figure 1). In accordance with the manufacturer's recommendations (InBody 720, 2005), all measurements were performed in the morning hours (from 8:00 to 10: 00h), the respondents have not had breakfast before measurement, not had a big meal the night before, as well as a long and heavy physical activity. During the test respondents were in the underwear, without jewelry, watches or other metal objects close to the body. Respondents stood calmly on the appropriate places on the platform, kept movable handles in the hands with stretched arms beside the body, waiting to the beep that signaled the completion of the measurement. To determine the values of the variables: body mass (BM), body mass index (BMI), body fat mass (BFM), skeletal muscle mass (SMM) and percentage of body fat (PBF), bioelectrical impedance uses electrical waves of different frequencies, where each individual frequency corresponds to the values of the appropriate - target variable (Völgyi et al., 2008).

Figure 1. InBody 720, *Multichannel Bioelectric Impedance*

Body height (BH) was measured with anthropometry according to Martin, which measurement accuracy is 0.1 cm. The respondents were in the standard standing position, on solid, horizontal surface. Feet were brought together, with heels, buttocks and upper back region slightly lean against the anthropometry. The head was in the Frankfort plane position without touching the anthropometry scale (Norton et al., 2000).

Statistical analysis

The results were initially analyzed by using the descriptive statistical procedures for the calculation of the basic measures of central tendency and measures of dispersion: Arithmetic mean (Mean), Standard deviation (SD), Standard Error of the arithmetic mean (Std. Error), the coefficient of variation (cV%), the limit values of range tolerance (Min and Max). Defining the difference was determined by the method of univariate analysis of variance (ANOVA). The level of significance was at the level of 95%, respectively, p≤0.05 (Hair et al., 1998).

RESULTS

Table 1. shows descriptive indicators of examined variables for both measurements.

Table 1. Results of descriptive statistics

I Ac. Year	Mean	Std. Error	Min	Max	Std. Dev	cV%
BH 1 (cm)	169.91	1.26	162.40	184.40	5.62	3.31
BM 1 (kg)	60.65	0.47	50.50	84.60	7.99	13.18
BMI 1 ($kg \cdot m^{-2}$)	20.96	0.66	18.20	26.80	2.10	10.00
BFM 1 (kg)	14.99	1.23	9.90	26.80	4.04	26.96
SMM 1 (kg)	25.10	0.44	19.70	34.30	2.95	11.75
PBF 1 (%)	24.43	0.64	19.00	35.90	3.99	16.32
III Ac. Year	**Mean**	**Std. Error**	**Min**	**Max**	**Std. Dev**	**cV%**
BH 2 (cm)	170.06	1.79	162.50	183.20	5.51	3.24
BM 2 (kg)	61.80	0.90	51.50	75.90	7.02	11.37
BMI 2 ($kg \cdot m^{-2}$)	21.33	0.89	18.40	26.70	1.95	9.15
BFM 2 (kg)	14.70	1.57	9.20	23.10	3.85	26.22
SMM 2 (kg)	25.84	0.86	20.70	33.40	2.85	11.02
PBF 2 (%)	23.63	1.01	16.70	32.90	4.54	19.21

Table 2. shows the results of ANOVA for all observed variables.

Table 2. Results of ANOVA

	F	Sig.
BH (cm)	.007	.935
BM (kg)	.232	.633
BMI ($kg \cdot m^{-2}$)	.334	.567
BFM (kg)	.056	.815
SMM (kg)	.643	.428
PBF (%)	.351	.557

DISCUSSION

The results of ANOVA showed that among the observed variables were not found statistically significant differences. However, from the results between two measurements obtained by descriptive statistics it could be seen that the respondents during the three years of study increased in variable BH by 0.15 cm and in variable BM by 1.15 kg. The increase in these two variables caused the increase in BMI from 20.96 $kg \cdot m^{-2}$ in the first year of study to 21:33 $kg \cdot m^{-2}$ after third year of study, or BMI in three years increased by 0.37 $kg \cdot m^{-2}$. Also, from the results of descriptive statistics could be seen that for the variables BFM and PBF there was the decrease of 0.29 kg and 0.80 %, while for variable SMM there was incrise of 0.74 kg. If the results of variables obsrve thrue the relative values expressed in procents, it could be seen thet change for BH was 0.09 %, for BM = 1.90 %, for BMI = 1.76 %, for BFM was 1.93 %, for SMM = 2.95 % and for PBF = 3.28 %.

In general, values of the single variables in this research are similar to the results in previous researches (Dopsaj i sar., 2009; Dimitrijević i sar., 2012; Dopsaj i Dimitrijević, 2013; Dimitrijević i sar., 2013). In the difference with previous researches, our results shows increase for the variable BMI between two measurements. The decrease of BMI in previous studies which has transversal character mainly can be attributed to the selection criteria, or standards to be achieved during the course of study. Specifically, on the first year of studies, a part of female student has higher values of body weight, which is an aggravating factor for the realization of physical abilities tests. Considering that this study included only female students that regularly examined all the faculty subjects, and that approximately 30% of them were enrolled in the third year compared to the first year of study, it is obvious that weight reduction is more problematic in relation to its increase. Participants in our research, in accordance with the Criterions of World Health Organization, belong to the category of *skinny* persons, but with a tendency to move to the category of *normally nourished*.

The results for variable BH should be interpreted with caution for enactment of serious conclusions. In fact, in previous research was concluded that the BH decreases on the third compared to the first year of study (Dimitrijević i sar., 2013). No matter that the measurement protocol was identical, with the same measuring instrument, the same measurer and in the same morning hours, the sample is too small to draw a reliable conclusion about the existence of increase in BH as a factor of development. Values of BH obtained in this study are very similar to BH values of female members of the Canadian police, 171 ± 8.0 cm (Jamnik et al., 2010), and slightly higher than for the ACPS female students in the previous research 169.57 ± 4.10 cm (Dopsaj i sar., 2009).

Our research has shown that BMI value should be taken only as a general indicator, since the BH is completely genetically determined, while the value of the BM is significantly conditioned by the living habits. Considering this, bodyweight gain in our respondents was achieved by reducing the BFM and increase SMM. Based on this, we can conclude that the process of changing in body composition occurs in a positive direction. The confirmation of this conclusion is also in the fact that our respondents, according to criteria of the World Health Organization, during the first year of studies belong to an *average value subclass*, while after the third year of studies they belong to the standard of *good physically prepared person's subclass*. This is especially important in regard to the characteristics of the police officers professional assignments.

As already noted, the limiting factor of this study was the small number of respondents. Further researches should be based on longitudinal monitoring which will allow more precise specific conclusions.

CONCLUSION

The number of women in the police force is growing. Determined level of physical abilities and morphological characteristics is necessary for successful performance of police work. For this reason, there is a need for constant monitoring of female students body composition indicators, as they represent a future police officers. Previous scientific practice in the area of morphology was mostly oriented to transversal researches, which could give insight into a general level of ACPS female student's morphological characteristics. From the results of this research can be concluded that, to monitor morphological characteristics during the studies at the individual level, longitudinal character researches can have a significant role.

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THE DIAGNOSIS OF ANTHROPOLOGICAL STATUS OF FEMALE ATHLETES BY APPLICATION OF MODERN BIOMECHANICAL METHODS

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SUMMARY

Biomechanics as a relatively young science plays a very important role in sport. By the application of biomechanical methods the diagnostics of anthropological status of athlete is being performed. Which method will be applied depends on a defined problem and on what we want to analyze and determine about the subject. This research analyzes the anthropological status in KL female athletes aged 10 years and TT aged 13 years who in the disciplines sprint and jumps achieved notable results. For the assessment of the status the biomechanical methods that were necessary in this study were applied. The results showed good condition of women fitness contestants, with the trend of their growth.

Keywords: athletics, diagnostics, biomechanics, methods.

INTRODUCTION

The application of modern biomechanical methods in top sport has a very important role. Development of modern biomechanical diagnostic methods in the world is very intense and is related to a number of biomechanical labs and institutes. Sport results at today's level of development of technology and methodology of sports preparation appear as the product of the planned, programmed and controlled process of sports training. The diagnosis based on new biomechanical methods has an extremely important role in the collection of relevant, objective, quantitative and qualitative parameters of sports training (Čoh, 2009). New diagnostic methods are the product of high technology and knowledge in biomechanics, physiology, functional anatomy, cybernetics, and other related branches. All these new technologies are mainly implemented in professional work with athletes who achieve high international successes. What is important is the fact that this method can be equally applied to all athletes, regardless of age, ie. whether it is a pioneer, or seniors. Sports training is a time process in which there is a continuous interaction between the development of psychomotor and functional abilities, morphological characteristics and technical training of athletes. Since the automated motor stereotypes and level of psychomotor abilities change, it is essential that the process of sports training is constantly monitored, controlled and if necessary corrected. As the most important objectives of biomechanical diagnostics are (Čoh, 2009):

- The control of basic and specific psychomotor abilities (strength, coordination, maximum speed, starting acceleration),
- The optimization of technical preparation and on this basis the improvement of the competition result,
- The construction of new methods for diagnosis of technical and motor sports training,
- The development of new technologies for tracking technical and motor sports training in athletes (kinematics, kinetics, electromyography, tensiometry, speed tests),
- The development of software equipment for measuring kinematic, kinetic and EMG parameters,
- The production of measurement protocols and servicing the information to coaches who work with athletes,

- The control of the training of athletes at the stage of immediate preparation for the important competitions,
- The control of technical preparation in competition conditions,
- The identification and analysis of errors in the sports technique, and removing of their causes.

All these modern laboratories operate on the principle of integration and synchronization of measurement systems and methods, enabling complex biomechanical analysis of motion structures and their control in the training process. Each method has its own purpose and exact aim to be achieved.

Kinematic method is based on registration of movement by using high-frequent video cameras with the speed from 50 to 1000Hz in the three-dimensional space. The method is non-invasive and it can accurately determine the movement of certain segments of the body, CTT, different segmentary accelerations, vector speeds, range of motion, angular velocity. The method requires synchronization of two or more cameras and a precise calibration of the real space. For this purpose are used infra-red cameras that operate on the principle of identifying markers on selected parts of the body of the athletes.

Dynamic method enables diagnosis of the forces that occur in specific movement structures. The most commonly used are tensiometric platforms for measurement of ground reaction forces in the horizontal (X), vertical (Y) and lateral direction (Z). This method allows the direct registration of dynamic parameters with great precision (frequency of 1000-2000Hz) and measures the force of reflection in running, low start, jumping in athletics, sports games, etc. There are three forms of diagnostics of jumping. Jumping in terms of neuromuscular activity is measured by vertical jump from half squat (squat jump-SJ) without swing of arms. In conditions of eccentric-concentric contraction we measure jumping by vertical jump with the opposite movement (Counter Movement Jump CMJ) where the muscles first stretch and immediately thereafter contract. According to research these jumps are 10-15% higher than the jumps that are performed only with concentric contraction. The third form of diagnostics of jumping in the eccentric-concentric conditions are drop jumps (Drop Jumps or Depth Jumps DJ), which are performed from a height of 25-60cm. Before landing the rebound should be performed so that there is no impact (contact) with heels on the surface.

Electromyographic method is used for the detection and registration of bioelectrical activity of muscles or muscle groups when performing specific movement structures (start-sprinting, running, jumping) at the frequency of 1000-2000Hz by the methodology SENIAM. In running THOSE are the muscles: m.soleus, m.gastrocnemius, m.tibialis anterior, lateral m.vastus, m.rectus femoris, M.biceps femoris, m.gluteus maximus. Surface electrodes are used which are associated with 6-8 channels and connected directly to the central unit data. By this method is obtained information about the time of activation of muscles, about what their intramuscular coordination is and what is the bioelectric activity of a certain muscle.

As a last method is Opto track method and is intended for testing the speed in different situations of training process. The system consists of measuring sticks with sensors and the central unit for collection and data processing. The basic unit-stick (100x4x3cm) has 32 photocells, with a space between them 4cm and they are placed 0,2 cm above the base. Once they are put together the total length of the instrument is 20m, and photo sensors register contact times with an accuracy of 1ms. It is one of the latest technologies for tracking locomotor movements of types maximum speed, starting acceleration, speed, deceleration speed, speed run up athletic jumps and start accelerating in polistructural sports. The basic speed tests are 30m flying start and 30 m from a standing start (start acceleration). By opto track method are analyzed: step length, step frequency, contact time, flight time and activity index of sprinting step.

All of these methods are applied in almost any sport and especially in athletics. Which method will be applied in the study, depends on what we want to get, which information, whether the movement of individual body segments, certain angles, the size of the force, or muscle activation.

It is this research that treat such an approach to modern technologies, that is, the analysis of the anthropological area in athletes by applying biomechanical methods to diagnose and determine their level of well trained skills.

METHODS

Subjects

The research was conducted on a sample of BIH female athletes, KL ages 10 years and T. T. age 13. The diagnostics included measurement of total 31 variables. The measurements were carried out in April 2010.

The sample of variables

A) Morphology

body height (AVIS), body weight (AMAS), leg length (ADUN), foot length (ADUS), diameter of ankle joint (ADSZ), the diameter of the knee joint (ADZK), the width of the pelvis (KFA), thigh circumference (AONTK), the volume of the lower leg (AOPTK), arm circumference (AONDL), subcutaneous fat of back (PMLE%), subcutaneous fat of biceps (PMBI%), subcutaneous fat triceps (PMTR%), subcutaneous abdominal fat (PMAB%), subcutaneous fat calf (PMLI%),

B) Motor control

standing long jump (MSDM), raising troops for 10 sec (MDT10), throwing a medicine-lying stomach (MBMS), throwing a medicine ball lying-back (MBMLE), hand tapping (MTAP), foot tapping (MTAN), vertical leap reach(MDOHV), vertical jump hands on knees (MCMJ1), vertical jump with momentum (MCMJ2), bend from a seated position (MPRET).

C) Kinematics

The sample of variables for estimating kinematic parameters of running in athletic sprint 20m included:

Time of contact (sec), Contact Height (mm), Step frequency (step/sec.), step length (cm), speed CT (m/s), the angle of running (º).

In the 40m sprint speed diagram and its oscillation is obtained by measuring lap times at every 5m, from start to finish. In addition to the final result, the times for each part of 40m were determined and average speed of movement (V), distance (S) passed in time unit (t). By calculating certain parameters the basic kinematic parameters were determined: speed of movement (v = S/t), top speed (Vmax), distance traveled (S = V x t) and elapsed time, both in parts and for the entire track (t = S/v) on the basis of which was obtained by the diagram running speed of above mentioned athletes. Morphological characteristics were measured by standard anthropometric instruments. The kinematic parameters were measured using the technology Opto-track (Microgate, Italy) and the system of infrared photocells (Brower Timing System). The photocells are placed at every 5 m from start to finish.

RESULTS AND DISCUSSION

Table 1. The parameters of anthropological status of female athletes

	Parameters	K.L (10 years)	T.T. (13 years)	Index Different
1.	AVIS-mm	1390	1554	1640 mm
2.	AMAS-kg	30,4	38,5	8,1 kg
3.	ADUN-mm	812	935	123 mm
4.	ADUS-mm	220	243	23 mm
5.	ADSZ –mm	63	61	-2 mm
6.	ADZK-mm	81	78	-3 mm
7.	AKFA-mm	221	227	6 mm
8.	AONTK-mm	420	460	40 mm
9.	AOPTK-mm	282	314	32 mm
10.	AONDL-mm	190	198	8 mm
11.	APMLE-%	46	56	10%
12.	APMBI-%	32	40	8%
13.	APMTR-%	72	90	18%
14.	APMAB-%	32	46	14%
15.	APMLI-%	68	110	42%
16.	MSDM-cm	176	204	28 cm
17.	MDT10-iter	11	15	4 iter
18.	MBMS-cm	450	530	80 cm
19.	MBMLE-cm	600	400	-200 cm
20.	MTAP-iter	26	34	12 iter
21.	MTAN-iter	21	22	1 iter
22.	MDOHV-cm	31	46	15 cm
23.	MCMJ 1-cm	30,9	33,8	2,9 cm
24.	MCMJ2-cm	36,4	39,7	3,3 cm
25.	MPRET-cm	16	18	2 cm

Table 1 presents the results of anthropological status of BIH women athletes. The differences are evident in all measured parameters of the morphological status among athletes T.T. (13 years) and K.L. (10 years). It is mainly about the greater values of athlete T.T.as expected, considering her age of 13, compared to age of the athlete K.L. aged 10 years. Period of 13 years is the period of puberty characterized by tumultuous psychosomatic changes of the individual. Only in diameter of ankle joint

(ADSZ) and the diameter of the knee joint (ADZK) higher value was obtained in younger athlete. From these diameters of transversality of joints caudal extremities, the likelihood is that the athlete K.L. will have a greater growth of body height and even greater height of the body from T.T. When it comes to the structure and percentage of body fat of some body regions also the higher values of athlete T.T. were observed. Of the motor parameters and the specific motor parameters differences are in favor of T.T. as expected, due to an older age with almost the same sports length of training. These differences in the motor parameters vary, depending on the space that was tested. For example in the variable for assessing segmentary speed (MTAN) the difference is in only one iteration or in variable MPRET, by which the flexibility was estimated, the difference is only 2cm. Also, the differences that are evident but not numerically high are in the variables for the assessment of the explosive strength (MCMJ1 = 2,9cm), and (MCMJ2 = 3,3cm). The only difference, but in favor of the athlete K.L. is in test throwing a medicine ball lying on back (MBMLE) in the index - 200cm. However, this result is a consequence of the weight of the ball (medicine ball) used in the test, it is not the same for ages 10 and 13 years, and this result was expected.

Table 2. The kinematic parameters of female athlete K.L. (age 10 years)

Steps	Contact Time (sec)	Contact Height (mm)	Flight Time (sec)	Frequency (steps/sec)	Step Lenght (cm)	Speed CT (m/s)	The angle running°
1	-	-	-	-	52	-	-
2	0,110	0,117	1,7	4,41	168	7,4	1,159
3	0,116	0,123	1,9	418	171	7,15	1,188
4	0,116	0,104	1,3	4,55	164	7,45	1,,076
5	0,122	0,123	1,9	4,08	174	7,10	1,182
6	0,116	0,116	1,6	4,31	168	7,24	1,153
7	0,117	0,122	1,8	4,18	174	7,28	1,176
8	0,116	0,117	1,7	4,29	168	7,21	1,159
9	0,116	0,116	1,6	4,31	174	7,50	1,139
10	0,117	0,128	2	4,08	174	7,10	1,209
11	0,117	0,122	1,8	4,18	177	7,41	1,170
12	0,110	0,129	2	4,18	171	7,15	1,220
13	0,116	-	-	-	-	-	-
Mean	**0,116**	**0,12**	**1,8**	**4,25**	**161,25**	**7,27**	**1,170**
St.Dev	**0,003**	**0,007**	**0,2**	**0,14**	**4,6**	**0,14**	**0,04**

Tables 2 and 3 present the kinematic parameters of the athletic sprint of young female athletes at 20m. Differences are evident in all kinematic parameters, but they are minimal. The only difference, somewhat more expressed, is in the average length of step and in the number of steps. Athlete T. T. ran a section of 20 meters in 12-step rhythm with an average length of step (Mean=189±4,45cm), unlike K.L., which the same part ran in 13-step rhythm with an average length of step (Mean=161,25±4,60cm). Differences are also manifested in the height of contact, the duration of the contact, time of flight, the frequency of steps, speed CTT and angle of running, and with better results in older athlete T.T.

Table 3. The kinematic parameters of female athlete T.T. (age 13 years)

Steps	Contact Time (sec)	Contact Height (mm)	Flight Time (sec)	Frequency (steps/sec)	Step Lenght (cm)	Speed CT (m/s)	The angle running°
1					177	-	-
2	0,129	0,116	1,6	4,08	186	7,95	1,114
3	0,123	0,116	1,6	4,18	189	7,01	1,107
4	0,129	0,116	1,6	4,08	189	7,71	1,007
5	0,135	0,104	1,3	4,18	192	8,03	1,007
6	0,134	0,110	1,5	4,10	189	7,75	1,063
7	0,123	0,110	1,6	4,29	189	8,11	1,063
8	0,129	0,116	1,9	4,08	192	7,84	1,101
9	0,128	0,123	1,7	3,08	192	7,65	1,146
10	0,122	0,117	1,3	4,18	192	8,03	1,108
11	0,134	0,104	1,4	4,20	192	8,07	1,007
12	0,141	-	1,6	-	-	-	-
Mean	**0,130**	**0,113**	**1,42**	**4,14**	**189**	**7,87**	**1,08**
St.Dev	**0,006**	**0,006**	**0,1**	**0,09**	**4,45**	**0,19**	**0,05**

It is worth of noting that in the athletic short track running, starting acceleration or speed of acceleration, is the first stage of effective running, in which the average response time depends primarily on the quality of the runner. Step length and frequency are the parameters that largely generate speed changes and in the starting acceleration, with increasing frequency increases also step length (Kugler & Janshen, 2010; Vanderka, & Kampmiller, 2011). The start and first steps are particularly important for sprinter and there is necessary a large concentration of attention, mental stability, coordination of movement and adequate strength and speed. If the time from the start to reach a maximum speed is less, then start of the sprinter is considered successful and at increasing speed, logically, its kinematic properties also change. First of all, in running on the track, the share of support phase is decreasing and the share of flight phase is growing and it is very important time relationship of the phase of flight and the phase of reflection in one step (Ciacci, Di Michele, & Measuring, 2010). In the starting acceleration, contact time of sprinting step shortens, and the flight time extends (Tables 2 and 3). The average frequency of step in K.L. was 4,25 steps /sec, with the length of the step 161,25cm, while in T.T. frequency was to 4,14 stps/sec with step length 189cm. This difference is expected because the increased longitudinality is accompanied by increased step length, where with the shortening of the time of contact also changes the type of strength (Kugler & Janshen, 2010). In the starting acceleration, where there is a relatively long contact time, the most important biomotor ability is the explosive strength of concentric modalities. On the quality of the starting acceleration significantly affects the length and manner of performing the first and the next steps after the start when the growth rate is realized with every new step because the force of each new reflection is added to an existing inertia of the body (Coh, 2002). The faster the running, the longer the step, the greater range of motion of arms and the shorter the period of reflection compared with the period of the flight (Hunter, Marshall, & McNair, 2005). In top sprinters phase of flight reaches 60% of lasting the step. So, the change of the running speed is achieved by changing its basic kinematic dimensions, the length and step frequency. Analyses and measurements show that with the increase in running speed, length and step frequency proportionaly grow (Tončev 2001; Čoh, 2002, Jovović, 2006; Mihajlovic, 2008; Pavlovic, 2010).

However, it turned out that while achieving high running speeds (over 7m / s) step length begins to grow more slowly and at the speed of 8-9m / s reaches its maximum. At the same time, step frequency continues to grow faster and generally by its increase is reached its maximum running speed. As the part of the running track is shorter the phase of flight is longer, and as the part of the running track is longer, the phase of flight is shorter (Delecluse, et al., 1995; Stefanovic, 1992; Jovovic, 2009; Idrizović, 2010, Hojka, Kubový, Bacak, 2012).

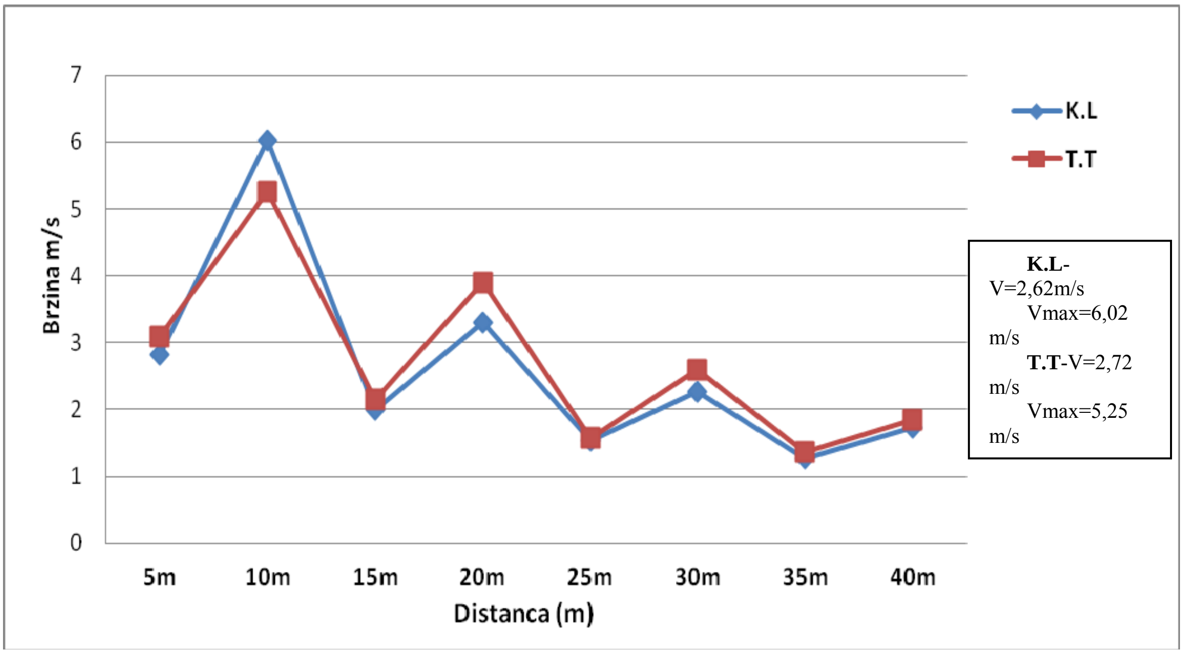
The kinematics of results (Table 4) shows that in both female athletes the first 10m passes in acceleration that linearly increases, and a max. running speed is achieved (Figure 1). Then it comes to a slight decrease to 15th meter (for 3s) and again the increase of speed to 20m (1,5-2s) and again a slight decline to 40m (Figure 2). This wavy movement of speed indicates the individual qualities and differences between female athletes. K.L. athlete has achieved greater acceleration in the first 10m (6,02m/sec) than athlete T.T. (5,25m/sec). The average running speed is almost the same at both contestants (2,62m/s and 2,72 m/s), with the fact that the running speed significantly declines faster in younger competitor K.L. than in the older, T. T. It is evident also that the frequency and step length is more uneven in the younger competitor (K.L.), while in older (T.T.) that is not the case.

Table 4. Kinematic indicators of running speed of women athletes at 40m

Parameters	Atl.	Distance (m)							
		5	10	15	20	25	30	35	40
T- (time) is the result of running	K.L	1,77	2,60	3,3	4,01	4,75	5,44	6,12	6,81
	T.T	1,61	2,41	3,12	3,60	4,43	5,07	5,57	6,34
T - (the result of distance) = s / v	K.L	1,77	0,83	2,5	1,51	3,24	2,20	3,92	2,89
	T.T	1,61	0,80	2,32	1,28	3,15	1,92	3,65	2,69
V- (speed of movement) = t / s	K.L.	2,82	6,02	2	3,31	1,54	2,27	1,27	1,73
	T.T	3,10	5,25	2,15	3,90	1,58	2,60	1,36	1,85

Some authors (Mihailov, 1989; Milanovic et al, 1986; Tončev 2001; Čoh, 2002, Jovovic, 2006; Idrizović, 2010; Pavlovic, 2010, Stankovic and Rakovic, 2010) found that running speed at the top sprinters increases with increasing the length of the steps, but only up to a value of 210 to 225 cm. Then growth of step length will not significantly affect the growth of the running speed, which is stabilized at about 9.5 m / s. In this case, in both contestants the maximum running speed is reached between 5th and 10th meter, then it comes to wavy movement with increasing and falling of speed, practically at every 5m up to 40m. Its motor equivalent is speed strength of an athlete, which corresponds to relation the strength-velocity of muscle. To a large extent depends on the speed of individual movement, maximum strength and frequency of step.

Graph 1. Display of oscillation of speed of women athletes running at 40m



This research is an indication of the relevant information that can be used, although here is about the women athletes of younger age. The exact anthropological profile has been obtained with all parameters, which are essential in the planning and programming of training process in athletics.

CONCLUSION

The research confirmed the fact that the importance of modern biomechanical methods currently in the sport has a growing role, and that the achievement of top results is unthinkable without the use of these methods. The results reflect an anthropological profile of young BiH women athletes and they are a good indicator of their current state in the physical and technical aspects. Also, the results can serve as a good information for further planning and programming of training process with a much clearer future tasks and goals of the training. What is needed, in order to use these methods are good and adequately trained measurers that in the best possible way would implement specific measurements. It is also necessary before the mere measurement to determine the basic goals and on the basis of those goals to apply the biomechanical diagnostic method that is intended for it.

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THE EFFECTS OF ISOMETRIC TRAINING ON ANTHROPOMETRIC CHARACTERISTICS

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SUMMARY

The aim of this research was to determine the effects of isometric training over a period of 10 weeks on the changes in anthropometric characteristics. The sample of participants in this study consisted of 30 males, aged 21 ± 6 months, randomly distributed into two subsamples. The experimental group (n=15) consisted of participants who took part in a specially programmed isometric training program, while the control group consisted of participants who were not included in any type of programmed physical activities (n=15). The anthropometric characteristics of the participants were determined at the beginning and end of the experimental program. The statistical method used in this study to determine the differences between the initial and final measuring included the univariate analysis of repeated measures (Repeated Measures ANOVA), while the univariate analysis of covariance (ANCOVA) and multivariate analysis of covariance (MANCOVA) were used to determine the effects of the training. The analysis of the obtained results indicates that the experimental programs led to changes in some anthropometric characteristics, but also opened up the possibility for new research which would include the application of alternate exercises with increased intensity.

Keywords: static exercises, skinfolds, circular dimensionality of the body

INTRODUCTION

The popularization of isometric training can be ascribed to the work of two German researchers, T. Hettinger and Muller (Hettinger & Muller, 1953). Isometric exercise was used extensively during the 1960s in the practice of well-known coaches such as J. Couhsilman in swimming training, T. Nett in athletics, B. Hoffman in weight lifting, and B. Petite in basketball. Its influence significantly grew within circular training as defined by R. Morgan and G. Adamson (Morgan & Adamson, 1959). Isometric training is also known as static strength training, as it activates muscles (Fleck & Kraemer, 2004), while at the same time does not lead to any changes in the size of the muscles themselves, or any perceptible movement in the joints. Isometric training does not require any expensive equipment, can be performed anywhere even though the number of exercises is small, and does not require much time. Despite the aforementioned advantages, isometric exercises in sports training only appear as additional exercises as they lack specificity (Zatsiorsky & Kraemer, 2009). The main drawbacks that were cited included: the fact that the development of strength is specific for a particular angle (the angle of the extremities), and thus the performance of exercises in various angles is recommended; the fact that during the performance there is no expulsion of breath, and thus it leads to an increase in blood pressure, which is why it is important to breathe continuously during the entire exercise. This type of training is applied in sports disciplines such as: judo, wrestling, skiing, sports climbing, archery, sports gymnastics and others.

The load during isometric training can be dosed through a combination of the number and duration of muscle contractions. These factors are combined to a great extent in practice, and thus we can speak of three methods of training: longs duration isometrics, maximal intensity isometrics, and ballistic isometrics. The application of isometric training includes three types of exercises. Of course, this does not include the combination of concentric and eccentric contractions during this kind of training. The outcome of the exercise itself is the same, that is, there is no movement (Siff & Verkhoshansky, 1999; Thibaudeau, 2007; Bompa, 2009). These kinds of exercises include: hanging exercises with various weights, pushing and pulling static load, extremity opposition exercises. Resistance in isometric training includes muscle contractions caused by one's own body, an immobile object, weights, a strength training device or elastic bands.

Training sessions which include isometric contractions lead to an increase primarily in isometric strength (Always, Sale & MacDougall, 1990; Davis, Parker, Rutherford & Jones, 1988), but some researchers noted certain positive transfer as well, which indicates the effects of this type of training on explosive strength as well (O'Shea & O'Shea, 1989). As a consequence of isometric training for the development of muscle strength, there is an increase in body circumference, which is ascribed to muscle hypertrophy (Kitai & Sale, 1989; Schott, McCully & Rutherford, 1995).

The aim of this study was to determine the effects of isometric training over a period of ten weeks on the changes in anthropometric characteristics.

METHODS

Subjects

The overall sample of participants in this study consisted of the students of the Faculty of Sport and Physical Education of the University of Niš. The selected participants took part in physical activities as a part of their classes at the Faculty of Sport and Physical Education. The overall sample of participants who took part in this study was 30, they were all males aged 21 ± 6 moths, and were divided into two sub-samples. The experimental group (n=15) was made up of participants who were included in a specially programmed isometric training. The control group (n=15) was made up of participants who only took part in regular daily physical activities at the Faculty of Sport and Physical Education.

Procedure

The experimental program lasted for a period of ten weeks. The initial measuring took place before the start of the program, and the final measuring after its completion. The experimental program included twenty training sessions. The participants from the experimental group performed static exercises (isometric training). The training sessions were designed by the authors of this research, who adhered to the recommendations of renowned authors who did research on this topic (Zatsiorsky, Kraemer, 2009; Verkoshansky, 1979; Bompa, 2009; Thibaudeau, 2007). Each training session was divided into three basic parts: the warm-up, the training activity and the cool-down period. Static exercises which made up the basic part of the training session included: pushing a partner from a arms raised forward horizontally position, pushing a partner from an arms raised laterally (abduction) position, a side bridge, one-arm push-ups, squats arms forward, squats, lunges and the bridge. Each exercise was performed three times for a period of 20 seconds per repetition during the first five weeks, only for the extent of the training to increase to 30 seconds per repetition over the following five weeks. After each repetition, a relaxation period followed, lasting for a period of 20 to 30 seconds, with an optimum duration of the rest period of 60 to 90 seconds per completed set. The intensity of the exercise was determined by the weight of the participant. The anthropometric characteristics of the participants were measured in the following manner: upper arm skinfold, with a precision of 0,2 mm, lower arm skinfold with a precision of 0,2 mm, upper leg skinfold with a precision of 0,2 mm, lower leg skinfold with a precision of 0,2 mm, upper arm circumference with a precision of 0,1 cm, lower arm circumference with a precision of 0,1 cm, upper leg circumference with a precision of 0,1 cm, lower leg circumference with a precision of 0,1 cm (using an anthropometer, as according to Martin). The participants voluntarily agreed to participate in the study, which was carried out in accordance with the Helsinki Declaration.

Statistical analysis

The statistical analysis included descriptive statistics, a univariate analysis of repeated measures (Repeated Measures ANOVA), a univariate analysis of covariance (ANCOVA) and a multivariate analysis of covariance (MANCOVA). The statistical significance was determined at the $p<0,05$ level. All of the data were processed using the SPSS 11.0 (SPSS, Chicago, IL) statistical package.

RESULTS

The mean value results for the skinfold variable (upper arm, lower arm, upper leg and lower leg) and circular dimensionality of the body (upper arm circumference, lower arm circumference, upper leg circumference and lower leg circumference) between the participants of the experimental group (n=15) and control group (n=15) between the initial and final measuring are shown in table 1.

Table 1. The descriptive statistical indicators for each group at the initial and final measuring.

Variable (unit)	Measurement	Experimental group		Control group	
		Mean	SD	Mean	SD
Upper arm skinfold (mm)	Initial	8,21	3,39	11,09	6,73
	Final	8,76	3,16	8,27	3,93
Lower arm skinfold (mm)	Initial	5,85	2,47	5,43	2,15
	Final	6,52	2,35	5,67	2,23
Upper leg skinfold (mm)	Initial	13,53	4,73	12,44	8,17
	Final	11,64	3,42	11,31	6,14
Lower leg skinfold (mm)	Initial	10,67	3,51	10,97	3,64
	Final	11,45	3,15	10,16	3,43
Upper arm circumference (cm)	Initial	30,07	4,23	29,75	1,83
	Final	30,59	4,32	29,66	1,93
Lower arm circumference (cm)	Initial	26,09	2,31	26,46	1,21
	Final	26,37	2,39	26,43	1,29
Upper leg circumference (cm)	Initial	52,89	4,38	53,52	2,58
	Final	54,05	4,62	53,49	2,58
Lower leg circumference (cm)	Initial	36,59	2,20	37,19	2,31
	Final	36,40	2,35	38,07	4,27

The intergroup differences in the values of skinfolds and circular dimensionality of the body between the initial and final measuring were tested using the univariate analysis of variance for repeated measures (Repeated Measures ANOVA). The results of the experimental and control group are shown in table 2.

Table 2. The intergroup differences between the initial and final measuring among the participants of the experimental and control group.

Variable (unit)	Experimental group		Control group	
	Wilks' Lambda	Sig.	Wilks' Lambda	Sig.
Upper arm skinfold (mm)	0,837	0,121	0,843	0,128
Lower arm skinfold (mm)	0,749	0,048	0,929	0,320
Upper leg skinfold (mm)	0,648	0,015	0,916	0,277
Lower leg skinfold (mm)	0,750	0,049	0,787	0,072
Upper arm circumference (cm)	0,851	0,140	0,986	0,658
Lower arm circumference (cm)	0,801	0,084	0,997	0,830
Upper leg circumference (cm)	0,571	0,006	0,999	0,914
Lower leg circumference (cm)	0,875	0,179	0,898	0,227

Based on the statistical significance, it can be determined that a difference between the initial and final measuring can be determined among the participants of the experimental group in terms of lower arm skinfolds (sig=0,048), upper leg skinfolds (sig=0,015), and lower leg skinfolds (sig=0,049), as well as upper leg volume (sig=0,006). In all these dimensions, except for upper leg skinfolds, an increase was determined in the average values. Among the participants of the control group, there were no significant differences between the initial and final measuring for any of the studied variables. The obtained results indicate that any specially programmed isometric training leads to statistically significant differences in the aforementioned variables.

Table 3. shows the results of the multivariate analysis of covariance (MANCOVA) which was used to study the effects of the experimental program on the values of skinfolds and circular dimensionality of the body. The results shown in table 3. were obtained by studying the participants of the experimental and control group.

Table 3. The results of the multivariate analysis of covariance (MANCOVA) between the participants of the experimental and control group.

Variable	Wilks' Lambda	F	Sig.
Experimental program	0,402	2,418a	0,076

The results of the multivariate analysis of covariance indicate that, in terms of the analyzed measuring, viewed globally, there are no statistically significant differences between the control and experimental group (sig=0,076). The experimental program had no statistically significant effects on the changes in the studied variables.

The effects of the experimental program on the individual values of skinfolds and circular dimensionality of the body were studied using the univariate analysis of covariance (ANCOVA). The results are shown in table 4.

Table 4. The results of the univariate analysis of covariance (ANCOVA) between the participants of the experimental and control group.

Variable (unit)	F	Sig.
Upper arm skinfold (mm)	1,258	0,272
Lower arm skinfold (mm)	1,555	0,223
Upper leg skinfold (mm)	,182	0,673
Lower leg skinfold (mm)	8,881	0,006
Upper arm circumference (cm)	2,439	0,130
Lower arm circumference (cm)	2,405	0,133
Upper leg circumference (cm)	6,111	0,020
Lower leg circumference (cm)	1,677	0,206

The results of the univariate analysis of covariance indicate that statistically significant differences of the changes in the studied variables can be found between the experimental and control group. Statistically significant differences can be determined for lower leg skinfolds (sig=0,006), where a more significant increase was recorded for the experimental group than that of the control group, as well as for the upper leg circumference (sig=0,020), where a significant increase was recorded for the participants of the experimental group. The experimental program had a statistically significant effect on two of the eight individually studied anthropometric characteristics of the experimental and control group.

DISCUSSION

Movements generate muscle contractions which usually include periods of muscle reduction and elongation, as well as the development of force which occurs without any changes in the length of the muscle itself. During training sessions, exercises often consist of only one of these types of muscle contractions. Irrespective of the type of muscle contraction, the effects on the muscle itself will be approximately the same. This indicates that a relatively clean model of movement results in a similar level of compensatory hypertrophy, which necessarily does not depend on the overall force generated during each contraction (Adams, Cheng, Haddad & Baldwin, 2004). The research carried out by Babault, Pousson, Ballay & Hoecke (2001) cites that one of the greatest advantages of isometric training is that the contracting regime leads to activation at the highest level. The activation refers to the use of motor units of the muscles. In this study it was determined that during the muscle activation in the maximum isometric regime, five more percent of several muscle units/muscle fibers are activated than during the activation in the maximum eccentric or concentric regime. In the study carried out by Schott, McCully & Rutherford (1995), it was concluded that the changes which occurred during prolonged isometric muscle contractions are statistically more significant in comparison to the intervals of muscle contractions related to the increase in isometric force and the cross-section of the muscle. The effects of the application of isometric training on the anthropometric characteristics have been proven in numerous studies (Garfinkel & Cafarelli, 1992; Kubo, Kanehisa, Masamitsu & Fukunaga, 2001; Kanehisa et al., 2002), irrespective of whether the topic of study were the effects on the upper or lower extremities. These studies indicate the positive effects of the application of various methods of isometric training on the increase in muscle circumference.

CONCLUSION

The effects of isometric training on the anthropometric characteristics have been studied in great detail, and their positive effect proven in numerous studies, especially those which refer to the increase in muscle circumference. The intensity of the exercises which were performed during the experimental program was determined by the weight of each individual participant, and there is a justifiable skepticism regarding whether this intensity is sufficient to cause adequate stimulation of the muscles. The obtained results indicate that the application of such an experimental treatment leads to changes in the skinfolds (lower arm, upper leg and lower leg) as well as to changes in the upper leg circumference, if we were only to consider the experimental group. An analysis of the effects of experimental treatment, where the results of both groups were compared, indicates that the skinfolds of the lower leg and circumference of the upper leg increased in favor of the experimental group. The experimental program leads to changes in some anthropometric characteristics, but also offers the possibility for some new studies which would also include the application of other exercises with increased intensity.

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HISTORICAL DEVELOPMENT OF ANTI-DOPING ANALYTICAL METHODS IN SPORT

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SUMMARY

Today the fight against doping in sports is regulated by the World Anti-Doping Agency (WADA) which was found in 1999. Still, the fight against the use of doping in sport has started much earlier, with the development of the Medical Commission of the International Olympic Committee (IOC) in 1967, whose task was to follow the obvious symptoms of the use of stimulants and other things that could unethically improve the performance of an athlete, as well as accidents in events whose results were fatal. The first goal of the fight against doping was to decrease the amount of death cases in athletic competitions, but they did not have the right tools up until 1972. As the science and technology progressed, the IOC and other accredited laboratories of the WADA found the new analytical procedures to uncover the use of doping. Today the methods for detection are even more reliable as the scientists constantly work on their further development. Current challenges for the anti-doping control is the DNA doping, but it is considered as undeveloped enough for the athletes to use it.

Keywords: analytical methods, doping, mass spectrometry.

INTRODUCTION

Doping control uses analytical methods since 1960. (Beckett & Cowann, 1978), since when, various measures for control of drug abuse in sport have been taken. The Medical Commission of the IOC was created in 1967 (Dirix & Sturbois, 1998) in order to observe obvious indications of abuse of stimulants and other opportunities for improving performance (Dirix, 1966) which involved occurrence of fatal accidents in sport such as were deaths of two cyclist in 1960 and in 1997. Medical Commission led by the Belgian Prince Alexandre de Merode initiated the first doping controls at the Olympic Games in Grenoble and Mexico City in 1968. Athletes on this competition were tested only for presence of highly effective performance enhancing drugs like amphetamines, heroin and cocaine. The first contester that has been tested in this sporting event was found negative on presence of searched drugs. Swedish pentathlete Hans Gunnar Liljenwall caused disqualification of the Swedish men's team at the same event for his alcohol use, and they eventually had to return their bronze medals. Doping control and analysis introduced at the Olympic Games in Mexico City can be considered as a pilot project, but systematic doping control and analysis had been carried out in all sports at the Olympic Games In Munich in 1972 (Clasing, Donike & Klümper, 1972).

Stimulants and narcotics detection by gas chromatography

Since 1969, the Medical Commission of the IOC regulated analytical methodology for detection of doping agents in urine samples. It established a prohibited list of substances with examples and defined criteria for their identification (Donike, Classing & Klumper, 1974). The list consists of stimulants, narcotics and painkillers with the list of examples and related substances meant to cover new synthesized substances with similar pharmacological effects.

Gas chromatography was the only sufficiently reliable method leading to punitive measures against suspected contenders. At the Olympic Games in Munich in 1972 the samples were screened by Gas Chromatography (GC) equipped with the nitrogen-phosphor detector (NPD) (Donike, Jaenicke, Stratmann & Hollmann, 1970). Mass Spectrometry (MS) has been already in use in that time, but it's application wasn't obligatory (Donike & Kaiser, 1971).

Prof. Manfred Donike, who was head of the institute of Biochemistry in German Sport University Cologne from 1977 until his death in 1995, was the initiator of introducing of MS in doping analysis. Through his engagement in many international federations and in IOC, foundations are laid for development of a quality doping control in laboratories all around the world.

Anabolic steroid detection by immunoassay

In the early seventies, anabolic steroids couldn't be tested with GC and MS because they weren't suitable for large scale testings which led to development of immunoassay (IA) screening test. IA screening testing begun in 1974 being used in European Athletic Championships in Rome, and also at the Olympic Games in Montreal in 1976 (Brooks, Firth & Sumner, 1975). In the same year IOC added androgenic anabolic steroids (AAS) to the list of prohibited substances.

Although it was suspected that there were cases of abuse of AAS in various sports much before 1975, this class of substances has been put on the prohibited list only when methods for their detection became available. IA screening test could detect a majority of synthetic steroids, but not all of them that have been popular at that time (Dugal, Dupuis & Bertrand, 1977).

However GS-MC method still hasn't been capable to immediately confirm results of IA. Several weeks later GS-MC method confirmed 8 positive results detected by IA. MS was used for identification of substances.

Detection of testosterone and other endogenous steroids

There were no reported cases of drug abuse at the Olympic Games in Moscow in 1980. However, there were rumors that AAS had been used. Doping tests constantly improved, but users found some new endogenous steroids. Unfortunately, neither GC-MS nor LC-MS are capable of distinguishing whether endogenous steroids originate from the human body or are purchased in a pharmacy or on a black market.

Doping analysis at the Olympic Games in Los Angeles marked a considerable change concerning the use of MS as a detection technique (Catlin, Kammerer, Hatton, Sekera & Merdink, 1987). It was expected radioimmunoassay to be used for screening of AAS, but experience from Moscow and improvement of the methods (Donike, Zimmermann, Bärwald, Schänzer, Christ, Klostermann & Opfermann, 1984) have changed this plan. In a period between the Olympic Games held in Moscow and in Los Angeles, extensive studies about presence of steroids in urine had been carried out. It was found that human urine contains a T isomer with no known biological function, epitestosterone (E). Donike suggested that for detection of testosterone, ratio testosterone/epitestosterone (T/E) should be used. .The ratio of T/E was only measurable with the use of GC-MS. At the Olympic games in Los Angeles in 1984, all samples (n=1510) were screened for AAS by GC-MS combined method (Catlin, Kammerer, Hatton, Sekera & Merdink, 1987). There have been 16 positive findings of presence of AAS.

Detection of steroids in urine was and still is important means in a fight against doping (Mareck, Geyer, Opfermann, Thevis & Schänzer, 2008). Today we have by WADA issued and defined rule that if ratio T/E is bigger than 4:1 (in some cases it was 6:1 and 10:1) than exogenous administration of it is disclosed. One of the problems with (T/E) ratio is that in some people - examinees this ratio is normally higher than requested maximum by WADA. The other problem is that in some examinees, on the other side, this ratio never exceeds this limit for genetic reasons (Jakobsson Schulze, Lundmark, Garle, Skilving, Ekström & Rane, 2008).

In the late nineties new method has been introduced – Isotope ratio mass spectrometry (IRMS) (Aguilera, Chapman, Starcevic, Hatton & Catlin, 2001)

Isotope ratio mass spectrometry

One of the highlights of low-resolution quadrupole MS detection happened without doubt during the Olympic Games in Seoul in 1988 (Park, Park, Lho, Choo, Chung, Yoon, Min & Choi, 1990). After setting a new 100 meter world record of 9.79 seconds , Canadian sprinter Ben Johnson was stripped of the medal because anabolic steroid stanozolol has been found in his urine sample. The doses this Canadian sprinter took, however, were allegedly lower than what the World Health Organization subsequently found to be safe to administer as a male contraceptive.

As users begun to use lower amounts of exogenous steroids, it was harder for laboratories to detect traces of AAS in urine samples. However, thanks to the High Resolution Mass Spectrometry (HRMS) method, detecting of little amounts of long lasting metabolites became possible (Schänzer, Geyer, Fußhöller, Halatcheva, Kohler, Parr, Guddat, Thomas, Thevis, 2006). At the Olympic games in Atlanta in 1996 HRMS method was used for screening purposes. Several samples with long lasting metabolites and with traces of AAS have been found.

According to technical documentation and rules issued by The WADA in case that urine samples after screening meet certain criteria (e.g. T/E >4) routine analysis is automatically required by IRMS.

Erythropoietin

In late eighties, there have been several cases of suspicious and unexplained deaths among young and healthy professional male cyclists. Between 1987 and 1989 around 15 professional cyclist died. It is widely presumed that these deaths are attributable to erytropoeitin (EPO) overdose (Cattlin, Hatton & Lasne, 2006).

First attempts of fight against EPO consisted of introduction of indirect blood tests. The simplest indirect test consists of measuring the haematocrit or haemoglobin. These blood tests are indirect tests because they do not detect the presence of recombinant EPO, only the footprints of use. Significant progress was made in 2000 when Lasne and de Ceaurriz described the method based on isoelectric focusing (IEF) (Lasne & de Ceaurriz, 2000). At the 2002 Olympic Games of Salt Lake City, the IEF test was successfully used to detect darbepoetin alpha, synthetic form of EPO. EPO has been put to the prohibited list of WADA although at that time no proper detection method had been developed. This is also applied for blood doping.

Flow cytometry and biological passports to detect blood transfusion

In the seventies, new doping procedure emerged. It was so called blood doping (Gledhill, 1981). Finnish long distance runner Lasse Viren blood doped his way to two gold Olympic medals in 1972 and in 1976 wining in 5000 and 10000 meters races. There is no clear evidence that blood doping was used in competitions before 1972. IOC prohibited blood doping only 14 years later in 1985 (Sytkowski, 2006). Doping analysis of blood samples for autologous transfusion was performed for the first time at the Winter Olympic Games in Lillehammer in 1994 (Bowers, 1997). The past few Olympic Games have seen the introduction of blood testing.

At the Olympic Games in Athens in 2004 flow cytometry has been used for detection of blood transfusion (Nelson, Popp, Sharpe & Ashenden, 2003). No adverse analytical findings were reported during the Games, because of a sample handling mishap, however, 2 weeks after the Games another sample from the same athlete had evidence for two populations of red cells in his circulation.

One of ways of preventing blood doping is introducing biological passports thanks to which monitoring of variations of indirect markers is made possible. International Cyclist Union from 2008 demands biological passports for all contenders of a highest level.

Growth hormone

Growth hormone (GH) is peptide hormone and is put on a list of prohibited substances issued by WADA in 2006. Until recently no reliable method for GH detection existed, so it can be only assumed that there was abuse of it in the past.

It is not known when was GH used for the first time as athletic performance - enhancing drug, but there is The Underground Handbook of Steroids – the earliest known publication on that subject that describes potential effects of the GH (Duchaine, 1989).This booklet is written in 1989 and it is clear that body builders and other athletes abused GH already. The true prevalence of GH abuse is unknown because we are primarily reliant on anecdote; however it is certain that GH is widely available to athletes. Ben Johnson is probably the most famous athlete that was using GH. He was disqualified after in his urine sample prohibited substance stanozolol has been found. Ben Johnson and his coach Charley Francis both admitted that Johnson abused GH combining it with also prohibited steroids at the Olympic Games in Seoul in order to increase his muscle strength and to recover faster from injuries (Mackay, 2004).

New method for detection of synthetic recombinant human growth hormone in serum samples was used in Athens in 2004. This method developed Strasburger with his associates (Wu, Bidlingmaier, Dall & Strasburger, 1999). So called isoform method is based on detection of RhGH isoforms. There are several isoforms of growth hormone. Around 70% of growth hormone is 22 kDa polypeptide, 5-10% as isoform 20kDa and the rest are dimers, oligomers and acids. When recombinant form is injected, only 22kDa form increases compared to other forms.

Abuse of GH can be detected through disturbed ratio of two natural forms of growth hormone in plasma (20 and 22 kDa) using combined method of Liquid Chromatography/Tandem Mass Spectrometry (LC-MS/MS) (Such-Sanmartín, Bache, Bosch, Gutiérrez-Gallego, Segura & Jensen, 2015).

Gene doping

Although gene doping is still considered as a problem in close or distant future, WADA has included a prohibition of gene doping within it's World Anti-Doping Code in 2003. Gene doping represents non-therapeutic use of genetically modified material. When we talk about gene doping, modulation of the gene responsible for synthesis of EPO is possible. Also we should pay attention to GH which improves muscle growth and muscle strength. When we talk about other proteins that could be possible targets to those modifications, we could mention also: insuline-like growth factor, myostatin, vascular endothelial growth factor, fibroblast growth factor, endorphine, enkephalin, α actinin 3, peroxisome proliferator-activated receptor delta and cytosolic phosphoenolpyruvate carboxykinase.

In 2006 president of the WADA, Dick Pound, said that gene doping is "a new threat that now is a reality". Although the problem was pointed out in 2006, available detection methods didn't detect it in 2008 in China nor it occurred 4 years later at the Olympic Games in London. However, it's not impossible that first cases of gene doping abuse might emerge in Rio in 2016. Currently, there is no specific gene doping abuse test that is approved by WADA or WADA accredited laboratories. Unfortunately gene doping detection is technically very difficult because proteins coded with modulated genes are identical to endogenous genes (Radovanović, Ranković & Jovanović).

CONCLUSION

Although the fight against abuse of prohibited substances in sport didn't give expected results yet, it will always be topical and important because the correctness of it's goal. Despite the fact that tests become more and more reliable and that they are constantly improving, it seems that doping users are at list one step ahead. Detection becomes more and more difficult because of emergence of new biotechnological products on the doping market. Fight against doping use must be brought to a higher level and analytical methods should improve constantly in order to keep the pace with new sophisticated doping substances and methods. However, all methods must be scientifically proved and checked in order to be successful in fight against prohibited substances in sport. At this moment, doping community has the advantage over it's opponent in spite of enormous efforts of WADA and in spite of great improvements of detection methods in last decade. Development of technology and science will contribute to the great extent to improvement of analytical doping detection methods in futures.

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KINEMATIC ANALYSIS OF HANDBALL JUMP SHOT

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SUMMARY

Jump shot is one of the most applicable and most attractive elements of handball, which is why it is of utmost importance to understand its structure usually determined by kinematic analysis through contemporary programs. Kinematics is the study of motion and as a branch of mechanics it deals with the switch of positions, speed and speed accelerations in all forms of motions, without considering the forces that influence that motion. A total number of only seven papers dealing with kinematic analysis of handball jump shot had been found and they were theoretically analyzed in this paper through descriptive method. Based on a collected data the conclusion was made that the phases of jump shot (approach, take-off, swing up (or flight), throwing and landing) can be most efficiently analyzed through kinematic analysis, which is considerably more accurate than any of the observational techniques used by handball experts. Obtained parameters can serve as an example of proper execution of jump shot in the process of training, but also in correction of existing errors.

Keywords: kinematic analysis, jump shot, handball, previous research

INTRODUCTION

Kinematics is the study of motion and as a branch of mechanics it deals with the switch of positions, speed and speed accelerations in all forms of motions, without considering the forces that influence that motion.

During the motion, one mobile point overlaps with series of points in space in the course of time. Linking of these points forms a line or path, i.e. trajectory of the mobile point. Trajectories formed in this manner can be represented by flat or curved series of points, or they can also lie either in level (two dimensions) or in space, i.e. in three dimensions (Bubanj, 1997).

Handball is aerobic and anaerobic sport of acyclic character where the collective success is contributed by physically well-prepared and technically trained professionals tactically incorporated into a whole that makes a team. Handball is the game of rapid character that prospers progressively and there are an increasing number of players who score goals with atypical, but yet attractive moves. One of the most applicable technical elements in the offense stage in handball is jump shot. Since 2003 up to now there have been only a few analysis of this element with an objective to obtain a principal model which would serve as the most correct example in jump shot training. Obtained data can serve as an instruction to coaches about the correct positioning of parts of body in the process of learning. A correct execution of this element and its automatization may prevent a great number of frequent injuries in handball (ankle sprain and twist, anterior and posterior cruciate ligament injuries, injuries of upper extremity joints, especially shoulder and elbow joints of the arm sending the ball towards goal).

The improvement of conditioning ability and technical and tactical knowledge is not enough for advancement of sport successfulness. Kinesiological and biomechanical analysis of the motion need to be carried out in order to understand the performance of existing motion techniques and, in accordance with the analysis results, new and more effective techniques of motion need to be developed (Meric et al., 2009).

The objective of this paper is to analyze previous research dealing with kinematic analysis of handball jump shot and to determine common points of all research concerning the given technical element.

METHODS

For the purpose of gathering, classification and analysis of the target research a descriptive method and theoretical analyses was used. Bibliography of publicly available papers was collected through internet search of “Google scholar”, “PubMed”, "Kobson" by using key words such as kinematic analysis, jump shot, handball and biomechanical analysis. Papers are also found and collected through references of paper referring to this or similar topic.

Papers were chosen based on several criteria. The first criterion referred to the title and key words. Narrower selection included papers with a note that by this were covered studies with problematic of kinematic analysis in handball. The second criterion was to analyze only the papers dealing with jump shot analysis, disregarding thus the papers that analyzed throwing of the ball, because these two elements, although similar, are very different in execution. The third criterion for paper selection was to have experienced handball players included in the research. Researches conducted in period from 2003 to 2015 were taken into consideration, which represented the fourth criterion for research paper selection.

THEORETICAL APROACH TO THE PROBLEM

The study covers seven chosen papers that met the set criteria. At the beginning of the search, 177 papers that matched some of the paper selection criteria were identified. Based on the title 83 papers were eliminated, and 27 others were eliminated based on other criteria (sample of participants, type of research and year of publishing) (fig.1). All of the selected papers are shown in Table 1 listed by these parameters: Sample of participants (number, gender and age of participants), experimental programme (the intensity of the programme, measuring instruments) and a conclusion.

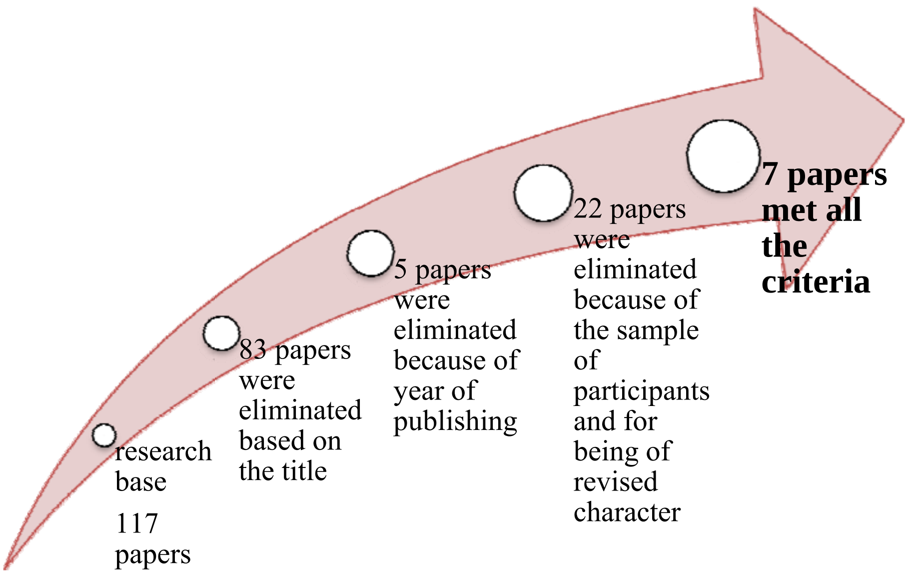

Figure 1.

RESULTS

AUTHORS AND YEAR	NUMBER	SEX	AGE	THE INTENSITY OF STUDY	CONCLUSION
Šibila, M., Pori, P., & Bon, M. (2003)	10	M	23.4 ± 4.2	- differences in some basic kinematic parameters -two different jump shot techniques used in handball -APAS (Ariel Performance Analyses System)	-There was no significant difference between kinematic parameters in the performance of the two types of jump-throw in handball
Pori, P., Bon, M., & Šibila, M. (2005)	10	M	23.4 ± 4.2	-assessing the jump shot with the method of expert modelling -APAS (Ariel Dynamics, California, USA) -expert modelling, SPEX expert system	-good criterion for assessing the quality of the basic technique of the jump shot for seniors
Šibila, M., Stuhec, S., Bon, M., & Pori, P. (2005)	1	M	26	-basic kinematic parametres of jump-shot techniques used in handball -top-level right-handed male handball player Ales Pajovic -APAS (Ariel Performance Analyses System)	-the results of the study are fully in accordance with previous results of other authors
Bubanj, S., Stanković, R., Marković, S. & Bubanj, P. (2007)	1	M	-	-basic kinematic parametres of jump-shot techniques used in handball - right-handed male handball player Sasa Bubanj - program for kinematics analysis of 2D	-the results of the study are fully in accordance with previous results of other authors
Begun, M., Mensure, A., Tuncay, C., Aydin, O. & Cigdem, B. (2009)	20	F	20-24	-arm and forearm segment movement in the backswing and acceleration phrases of plazers performing the volleyball sprike and the handball jump-shot were evaluated -Simi Analysis 5.5 program	-handball players transformer the velocity used in horisontal flexion to the vertical flexion in a short period of time
Wagner, H., Buchecker, M., von Duvillard, S. P., & Müller, E. (2010)	26	M	21.2 ± 5.0	- differences in ball release speed in team- handball jump throw - groups of different levels of performance - analyze upper body 3D-kinematics - the Vicon MX 13 motion capturing system (Vicon Peak, Oxford, UK)	- team-handball players who were taller and of greater body weight have the ability to achieve a higher ball release speed in the jump throw
Ohnjec, K., Antekolović, L., & Gruić, I. (2010)	4	F	14-20	-the kinematic variables sample set was made up from the parameters related to the specific phases of a jump shot -Ariel Performance Analysis System (APAS, Ariel Dynamics inc., USA).	-The results of these study might be used to improve and correct the performances of the players within the process of their technical development (correcting mistakes).

Table 1 Chronological and spreadsheet display of the chosen researches

DISCUSSION

In the analyzed studies there were two papers which consisted of only women as participants, while in all other papers the sample of participants involved male participants, two of which were case studies (Sibila, Stuhec, Bon & Pori, 2005; S. Bubanj, Stankovic, Markovic & P. Bubanj, 2007). If we except papers with one principal model, the least participants counted 4 (women) (Ohnjec, Anteholovic & Gruic, 2010), and the most counted 26 (men) (Wanger, Buchecker, von Duvilard & Müller, 2010). The age of participants ranged from 14 to 26 years old.

Jump shot is one of the most applicable specific elements of motoric behavior in handball which is why it is crucial to know its structure. Fundamental phases which make this element are: phase of approach, phase of take-off, phase of swing up (or flight), phase of throwing and phase of landing. These phases are visible to the bare eye of an expert, however, their most precise determination is done through kinematic analysis. The execution of jump shot in situational conditions is conditioned by many factors that are components of the game. Some of them are position from which the jump shot is executed, resistance of the players of the opposing team, the influence of muscle fatigue etc. The success of the executed shot to the goal is one of the key effects of successfulness at handball game, around a half of all the shots towards goal is from a position of outer players, and 60% of it is by a technique of jump shot (Pori, Bon & Sibila, 2005).

For the analysis of a technical element in sports a special equipment is necessary, the one that fulfills all the set conditions of a process. In studies dealing with this problematic, certain devices were used, such as "APAS" (Ariel Dinamics, California, USA) (Sibila, Pori & Bon, 2003, 2005; Sibila, Stuhec, Bon & Pori, 2005; Ohnjec, Anteholovic & Gruic, 2010), programme for kinematic analysis in 2D (S. Bubanj, Stankovic, Markovic & P. Bubanj, 2007), Simi Analysis 5.5 programme (Begun, Mensure, Tuncay, Aydin & Cigem, 2009), the Vicon MX 13 motion capturing system (Vicion Peak, Oxford, UK) (Wanger, Buchecker, von Duvilard & Müller,2010).

In research of Pori et a. (2005) in evaluation of the expert model participated the commission as well, consisted of three experts in the handball field, giving evaluation based on visual effect of the jump shot execution. Of the utmost importance in the analysis was the phase of throwing (39%), phase of take-off (32%), and phase of swing up or flight (18%), while the phase of approach and phase of landing were less observed. The most important parameters in certain phases of jump shot were: the duration of the contact with the base during the take-off, the height of throwing and the speed of ball. The results showed that the success of jump shot execution depends on anthropological status, as well as the motoric capabilities of participants, regardless of the position the participants execute the element from. Research by Wagner et al. (2010) confirmed that the higher speed of the ball was achieved by participants who were taller and had more body weight. However, it is important to emphasize the research (Wagner, Pfusterschmied, von Duvillard & Müller, 2011) which determined that the higher speed of the ball is achieved when the shot is executed from the ground run, then from the jump. Any qualified coach can spot the irregularities in jump shot execution even without the usage of some complex analysis. An increase in trunk flexion, trunk rotation and shoulder internal rotation angular velocity should result in an increase of ball release speed which confirms the fact about the effects of the anthropological characteristics and motoric capabilities on the successfulness of the jump shot execution (Wanger et al., 2010).

Comparing of two types of jump shot techniques revealed that the jump shot execution from the take-off leg, opposite to the arm which a player uses to shoot, is considerably more efficient than to shoot from the take-off leg and arm which are on the same side (Sibila, Pori & Bon, 2003). In a very short time interval the speed of the arm is transferred from horizontal to vertical level, which enables faster throw-out of the ball with female handball players in research Begun et al. (2009) in comparison to spike technique of the volleyball female players who conduct higher vertical flexion, which increases the time needed to achieve the needed speed of the arm.

With the objective to enhance and correct the jump shot technique in the training process, and by determining the relevant indicator for future training programme planning Ohnjec, Anteholovic and Gruic (2010) analyzed female handball players of different age categories up to junior age. According to Pori, Bon and Sibila (2005), expert model was used as the most correct example of jump shot execution and all of the phases analyzed to obtain the model were tracked. The throwing of the ball was tracked from the moment of the swing up phase and it is believed to be the most efficient if the elbow of the arm holding the ball highly placed, in level with the head, while the muscles participating in the kinetic chain itself manifest the explosive type of strength. Only one female participant threw a ball in the moment of the highest point of swing up, while all of the others threw a ball in moments after reaching the highest point of the swing up. This fact gives space to perfect and correct the mistakes during the jump shot performance in order to get as close as possible to the expert model. Landing can be performed with one or both legs, where there is a possibility of continuance of motion during the amortization of foot with the ground.

All of the described elements of expert model in Pori, Bon & Sibila research (2005) coincided with the analyzed elements of the model in Pori et al. (2005) and S. Bubanj et al. (2007). The hypothesis were confirmed that the speed of segment of an arm from which the throwing of the ball is performed (shoulder joint, elbow joint and the root of the wrist) is notably influencing the speed of the ball and that the vertical speed of the segment of non take-off leg (hip joint, knee joint and ankle) considerably effects to maximum height of body center during the take-off. This research involved right-handed players, but the assumption is that the same results would be obtained if the left-handed players were subjected to the research, for the reason that in their case the left hand is their "stronger" hand and it enables the identical motion control.

CONCLUSION

Jump shot is very present technical element in handball, it is performed from all player's positions and it is exactly the reason why, together with other situational conditions (the resistance of opposing players), it is modified according to every player who performs it at the moment. The successfulness of this element depends on many factors, firstly the anthropological and motoric features of every individual. Jump shot can be performed in vertical jump or long-jump, but no matter the direction it is consisted of several phases (phase of approach, phase of take-off, phase of swing up (or flight), phase of throwing and phase of landing). With the help of special programmes for kinematic analysis the listed phases were differentiated and parameters affecting their improvement were analyzed. In order to perfect a jump shot, a player needs to work on enhancing of the physical strength (the explosive strength of arms and legs), elasticity and pliability of the upper body. At the beginning phase of the handball technique training process, it is crucial to emphasize the proper positioning of the upper and lower extremities in order to make the ball release faster and more efficient. It is well known that goalkeepers are less responsive to balls sent to goal in high speed, but they are just a product of kinetic chain starting from the take-off leg, meaning through ankle, knee joint, hip, through trunk flexion and rotation up to the arm (shoulder joint, elbow joint and root of the wrist). The ball leaves the hand at the moment of the highest point of flight phase and, depending on the impulse sent to it, it flies faster towards a goal.

This paper analyzed seven scientific research studies by a descriptive method and the suggested conclusions were made which makes the objective of this paper reached. Handball is the sport which prospers progressively and handball players seize to impress the viewers and scientists with their individual capabilities and innovations which are an upgrade of already existing game elements. Young coaches have the presented expert model of jump shot based on which they can train young handball players and correct possible mistakes in training process. The suggestion for further and upcoming research is to make a jump shot kinematic analysis of all national teams, participants in male/female upcoming championship for seniors and to precisely describe parameters characteristic for each player position (wings, outer attacker – left, right, middle, pivot), and best ranked players take for the "expert model".

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NEGLECTED LANGUAGE OF SPORTS COMMENTARIES CAN FOSTER AGGRESSION

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SUMMARY

Aggression or sportsmanship can be learned and reinforced in many different ways. Multiple reasons, rather than a single one, influence such behaviors. Young athletes need positive, appropriate, and constructive role models to teach and reinforce sportsmanship and moral reasoning (Nucci & Amp; Young-Shim, 2005). The coach is perhaps the most significant person influencing the amount of aggressive or sportsmanlike behaviors displayed in the competitive sport context (Conan, 1980; Cratty, 1983; King, 1990; Terry & Jackson 1985). Smith (1983) reported that nine percent of hockey players (N=166) between the ages of 12 to 13 perceived their coaches as approving of hockey violence. The role of referees has also been identified as a significant factor affecting athletes' subsequent behaviors (Lefebve, Leith, & Bredemeier, 1980). The role of sports commentaries and the language used should also be observed in order to classify them into objective, judgmental or historical ones, and to attribute them their vital role in sportsmanship development.

Keywords: sports commentaries, aggression, sports, role model, coach.

1. INTRODUCTION

Parents sometimes push their children into competitive sports. They may wish to realize their personal, unfulfilled desires through their children, or to have their children exposed to excessive competition, believing it is appropriate preparation for later, adult life (Nucci & Young-Shim, 2005). Failure of referees to correct an athlete's aggressive behavior may reinforce and increase the probability of recurrence (Nucci & amp; Young-Shim, 2005).

Pagelow (1984) noted that aggressive children tend to have aggressive parents and that parents can be strong role models of aggression. Similarly, Freishlag and Schmidke (1979) stressed the importance of parents' influences on young athletes' moral reasoning (Nucci & Young-Shim, 2005). The potential role of media should be recognized in moderating aggression in sports (Lefebvre, et al., 1980). The broadcaster should identify aggressive and unsportsmanlike behaviors immediately in terms of rule regulations and sportsmanship conduct. Sullivan's (1991) study explored the impact of television commentary on viewers' perceptions and enjoyment of player hostility, including violent behavior, in the context of a less combative sport. Effects of fanship, gender, and varying levels of commentary (dramatic, neutral, no commentary) were tested.

A videotape of a heated Georgetown versus Syracuse men's college basketball game provided stimulus material, with the dramatic commentary treatment contradicting the visual evidence as to which team was the aggressor (1991). Strong medium effects were reveled, with viewers of the dramatic commentary treatment perceiving Syracuse players as being significantly more hostile, in line with the manipulation. Men were more likely than women to enjoy the fighting in the game segment, but fans' perceptions of opponent hostility were as vulnerable to the biased commentary as those of non fans (1991).

Three seminal studies examined bias in commentary and its relationship to viewer responses to player hostility (Sullivan, 1991). Comisky, Bryant, and Zillman (1977) and Bryant, Comisky, and Zillman (1981) found that appreciation, including enjoyment, of heavy contact sports contests (professional hockey and professional football, respectively) is facilitated by roughness, enthusiasm, and violence of play, and that commentary alters viewer perception of rough play (Sullivan, 1991).

It is important to note that the stimulus material used in these studies was game action that, regardless of intensity, reflects normative player behavior for hockey and football and is clearly within the scope of the game's rules.

2. COMMENTARY TYPES

The third study on commentary bias (Bryant, Brown, Comsiky, & Zillman, 1982) manipulated the affective relationship between players rather than roughness of play. Bryant, et al. (1982) varied commentary to manipulate the affective relationship between tennis players, finding that increases in perceived enmity, intensity of play, and competitiveness between opponents contributes to viewer enjoyment (Sullivan, 1991). Since television most often mediates this intense fan experience of sport (Bellamy, 1989; Eastman & Meyer, 1989), commentators serve a central role in influencing public perceptions of violence in sports contests. The chief role of commentary traditionally has been narrative in function (Sullivan, 1991).

In this role, commentators use a set of descriptive narrative modes- objective, judgmental, and historical- to tell the game story (Morris & Nydahl, 1983). In its objective mode, commentary complements the camera by summarizing what has occurred in the game. In the judgmental mode, commentary assigns motivations to player and team performance and player behavior (Sullivan, 1991). Commentary that places players, teams, and games in historical perspective typically relies on biographical material and statistical comparisons.

Descriptive narration demonstrates the commentator's credibility as game expert. Commentators, for example, borrow liberally from the descriptive language of the locker-room; cued by jock jargon, viewers believe they are getting "shop talk" (Snyder & Spreitzer, 1983)

Bryant and Zillman (1983) note that rough and aggressive action would represent "human conflict at its peak and intense conflict is the heart and soul of high drama" (p. 7). By extension, violence can be considered the ultimate in human sports conflict with increases in viewer enjoyment corresponding to increases in the likelihood of serious injury to the athletes (Sullivan, 1991). The fight fan cherished the heavyweight who delivers the knockout, the football fan idolizes the linebacker who wrecks quarterbacks, and the hockey fan cheers the defense man who uses his elbows in the corners and his fists around the goalmouth. Players' violence attests to their will to win (Sullivan, 1991).

The nature of heavy contact sports, the rules that govern such sports, media attention, the lack of punitive deterrents to fighting, and American society's emphasis on outcome rather than process all contribute to players' use of violence in contact sports, coaches and players perceive the use of intimidation and aggression as a vital ingredient to winning (Swift, 1986). In programs that emphasize win-loss records, players are more likely to use intimidation through violence (Smith, 1978; Tyler & Duthie, 1979).

3. USING VIOLENT LANGUAGE COULD ALSO ENCOURAGE AGGRESSIVE AND VIOLENT BEHAVIORS

Using violent language could also encourage aggressive and violent behaviors. Wren (1991) made a strong comparison of using violent language to smoking: Language, like tobacco, is habit forming. Some patterns of writing and speaking are addictive and may damage both the user and the others who breathe the same linguistic atmosphere. If we can see the damage being done and decide to kick the habit, we may get withdrawal symptoms and hostility or derision from other smokers. But in the end, we shall enjoy breathing fresh air (Holt, 2000, p. 102).

The language used in sports print journalism is also evident of the connection of violence and sports (Holt, 2000). Particularly since the 1985 Heysel Stadium soccer massacre, even some sports journalists have begun to view violence in sport as problematical. Dwyre (1996), for example, reflecting on a long career as a reporter of sporting events in the US, concluded: "Sportswriters tend to view sports-related violence such as fights between opposing team members, vicious boxing matches, and assaults on players as part of the game rather than an intolerable an offensive incident.

Violence in sports should not be so easily tolerated" (Holt, 2000). Writing in Sports Illustrated, Wulf (1988), in similar vein, criticized the president of the US national ice-hockey league for denying that the league was prone to violence while at the same time marketing videos with titles like; "Brand New. Part Four. Hockey's Bloodiest Fights." Knockouts' Holt's (2000, p. 89) study consisted of a sample of ten per cent of the annual diet of newspaper sport reporting of the inhabitants of New Zealand's largest city, Auckland, being examined from the point of view of the most salient features of language for a period of 35 consecutive days (five calendar weeks - 1 June to 5 July).

In sifting the language of the sports supplements in both newspapers (New Zealand Herald and Sunday Star Times), it was clear that many of the characteristics of journalistic style generally were present; these included: dramatization of headlines (e.g., 'Kiwis Light Up Night'); idiomatic and emotive diction (e.g., 'The game is screaming out for guidance on what has become an extremely ugly turn of events'); the blurring of the border between information and entertainment; the meshing of visual images with concept, including advertising layout; simplification or trivialization of content; and the use of clichés and catch-phrases (e.g., 'on-a-roll captain finds X's Achilles heel') (2000, p. 90). The most salient or distinctive element of journalistic style for sports reporting in the present sample was found to be images of violence.

4. MILITARY METAPHORS IN LANGUAGE OF SPORTS

It can be said that press does not set limits to the coverage of topics and uses all that reflects the social interests and sports as an inseparable part of life is not out of limelight of the media. Sports news is part of thematic lines of the news and magazines but also of the specialized issues devoted solely to sports. The presence of military metaphors in sports publications is not neglectable. They are just being transferred from the arena of sports commentaries into the printed form.

Athletes wage *wars* and *battles,* march into *attacks* and *counterattacks,* organize *defense.* Matches are often called *wars, battles, struggles, conflicts*. When describing, or commenting sports matches, games or competitions it is inevitable to use military terms, and their use is widespread, and certainly not limited to just one, dominantly Anglo-American speaking area.

To name but just a few of military metaphors we quote the following used in Serbian sporting arena:

1. *Battle* (Air battle: Zigic versus Drogba! (The Blic - Monday, September 7, 2009.)
2. *Lightning war - Blitzkrieg* (Efficient - " *Blitzkrieg* " tempered down the tempo of Nadal's game and in just half and hour he used his firm serve to take a lead 1:0. (The Blic - Monday , August 24, 2009.)
3. *Bombarder (*„Bombarder from Bukulja " emphasizes he is sure to be active for more than seven-eight years and then transfers to coache's bench. (The Public Voice – Sunday 12, April, 2009.)
4. *Bunker* (Ukrain bunker resists (The Politika - Monday 7, September, 2009.)
5. *Sniper* (A Serb the first sniper of America (The Public Voice – Sunday 16, March, 2008.)
6. *Squad* (Blue squad mauls the roosters (The News – Monday, 07/06/2009)

Murging of military lexicon into the sports one is not accidental. Military and sports terminology systems are close ones in that they are not isolated from the general lexicon and both systems are extremely popular. Арутюнова, 1990, mentions several causes of the active use of military lexicon in the language of sports. One of them is the frame of mind of different peoples that have war as one stabile architype. Forms of sports were originally preparation for the battle and wars. The other reason is the increased role of sport that has brought about competition between athletes. This competition is characterizead by increased agression, a burning wish to win at any cost. A vital role was also attributed to everlasting conflict between the capitalism and socialism that was reflecting on sports areas as well.

This study did not concern itself only with the relatively innocuous terms that have long been assimilated into the normal, basic vocabulary of sport, such as: 'to win, to beat, victory over, to defeat, to lose, etc. These refer to an underlying metaphor of 'battle', which reflects the competitive nature of sports generally, but through time, common usage and familiarity have achieved the status of 'dead' or 'frozen' metaphors that are taken more or less literally (2000, p. 90). Rather, this study was concerned with more consciously graphic images that have not (or, not yet) lost the true metaphor's relative vividness of effect.

5. CONCLUSION

Examination of the 35 separate sports supplements/sections revealed the images to be focused on four major metaphorical complexes. The one most frequently occurring has been simply labeled 'violence' and concerned language used to evoke related notions along a spectrum from injury to killing. All three main classes of content-words (nouns, verbs, and adjectives) are widely used, with a slight preponderance of verbs. The next most frequent complex was a 'military' metaphor, which also incorporated associated terms from semantic fields like 'hunting' or the 'cowboy Western'. In this particular word sample nouns and verbs tended to be roughly equal in number, with adjectives being largely absent, suggesting semantically a relatively equal emphasis on process and product aspects. The third most frequent key metaphor discovered was that of 'mechanization' or 'machinery'. The word usage in this sample follows the patterns of the previous sample. The final complex related closely to the machine-metaphor, but differed in that it went a step further by representing particular body parts as machine parts; what one might term a 'robotic' model (2000, p. 93). The significance of the machinification-metaphor represents an attempt to camouflage the true physical effects of violence; as Bataille noted: '(language can often substitute) the appearance of a solution for the insoluble, and a screen for violent truth.'

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GENERAL MODEL OF SPECIFICATION EQUATION AND QUANTITATIVE INDICATORS OF LEG EXTENSORS` EXPLOSIVE FORCE IN ELITE ATHLETES

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SUMMARY

The aim of this research was to define a practical multidimensional model for assessing the general level of leg extensors' explosiveness preparedness in top-level athletes of both genders from the disciplines that were divided into the following groups: 1) speed-strength sports, 2) sports with a complex manifestation of all motoric properties, 3) endurance sports and 4) untrained individuals by applying a set of 5 variables measured by standardized "isometric leg press" test. The results indicated that there were general statistically significant differences in comparison with the index of general leg extensors' explosiveness preparedness (RFD_{SCORE}) between the analyzed groups. Regarding observed explosiveness indicators in both female and male athletes from the speed-strength sports group preparation in the category very good – excelent was established, i.e. the highest RFD_{SCORE}. These results emphasize influence of adaptation in different exerted muscle force characteristics, but also the coherence of sport branch and the production of muscle force contractile characteristics.

Keywords: multidimensional model, leg extensors' explosiveness, physical preparedness

INTRODUCTION

Regarding the sports-training processes, applied in multi-annual athletes preparing to achieve more, i.e. the highest results in sport, it is necessary to establish an adequate system to control and trace physical property development in athletes or teams in order to obtain returned information on their training levels (MacDougall et al., 1991). Based on the given data, the coach can trace the tested physical property level, i.e. competitive training level, trace changing tendency in comparison with previous results (regression, stagnation or progression) of the athlete or team and correct the training program with regard to a suitable level of development or fitness. In general, managing the training process depends on the adequacy of the system for collecting information on athletes or a team's training level in order to give precise access to all or the required aspects with regard to the training level (Koprivica, 2002; Stefanović and Jakovljević, 2004; Zatsiorsky and Kraemer, 2006; Milišić, 2007; Ivanović, 2009).

With today's level of development for competitive results in top-level sport, information obtained based on athlete testing, which ensures basic data on the training level for a certain physical ability, is not specific enough to achieve complete control over the training process. The importance of valid diagnosis for explosiveness, i.e. explosive muscle force, i.e. F-t dependency, comes more to the fore with the fact that the time necessary to reach the required level of muscle force in an isometric, pseudoisometric or transitive regime of muscle contraction is crucial for motorics, i.e. for the realization of each and every movement activity (simple and complex, as well as basic and specific movement activity) while performing maximal speed moves (Mero, 1988; Kyrolainen et al., 2005; Marković et al., 2007).

Models are one of the basic cognitive instruments in science. Their significance lies in the fact that they can successfully remove subjectivity as the basic default of man's way of thinking (Ristanović, 1989). One of the basic facts that must be taken into consideration when it comes to examining complex (especially biological) systems is the so-called "analogy principle". It is based on the well-known fact that similar phenomena often occur in completely different systems. These systems are mutually similar (analogue). From the "analogy principle" its improved version, a method of modelling, was derived (Krajzmer, 1985; Ristanović, 1989; Ristanović and Dačić, 1999). Modelling is one of the basic methods in modern science, which is based on constituting and improving models of examined systems and phenomena (Ristanović, 1989; Ristanović and Dačić, 1999). Modelling is based on the fact that certain phenomena, which are concretely manifest and examinable within one system, can be recognized and followed within another system that is analogous to that phenomenon. If we observe phenomena in two analogue systems, the results of monitoring or measuring one of them might be used to predict the flow of phenomena and properties in another analogue system. Producing the model of the athlete's state is significant for successful training process management, as well as for athlete selection. Comparing such model with the present state of the athlete enables an increasingly rational "managing" of the preparation process.

The subject of this research was focused on defining the model characteristics of different leg extensors' explosive force indicators measured at the level of 100 ms, 180 ms, 250 ms, 50 and 100% of maximal force (Fmax) in bilateral extersion conditions in top-level athletes of both genders from the disciplines that were divided into the following groups: 1) speed-strength sports, 2) sports with a complex manifestation of all motoric properties, 3) endurance sports and 4) untrained individuals.

The aim of this research was to define a practical multidimensional model for assessing the general level of different F-t curve indicators for the evaluation of leg extensors' explosiveness in top-level athletes of both genders, in order to obtain the most informative indicators which will improve the technological process of managing, controlling and monitoring the training level of an athlete, and to control and optimise the training process.

METHODS

Subjects

378 examinees were divided into 8 groups according to gender and the specificity of the training process to which they were subjected in the course of participating in this research. With regard to gender, the sample of females consisted of 142 examinees and the sample of males consisted of 236 examinees.

Based on a different sport classification obtained from the available literature (Koprivica, 2002; Dopsaj, 2010), top-level athletes in this research were divided into three basic groups: 1) speed-strength sports, 2) sports with a complex manifestation of all motoric properties and 3) endurance sports.

Procedure

Maximal isometric force was measured using a leg extension dynamometer (Serbian Institute for Sport and Sport Medicine, Belgrade). Subjects were seated on a bench, so that their hip angle was at 110°, knee angle 120°, and ankle angle 90°. After individuals had warmed up for five minutes and received an introduction to the measuring procedure, each subject made two attempts, with one minute of rest between trials. The subjects were instructed to exert their maximal force as quickly as possible. In order to assess the contractile characteristics of the isometric muscle force of leg extensors (during bilateral exertions), standardized equipment was used, i.e. a metal device. A footplatform fixed to the frame by strain-gauge transducers and a standardized "isometric leg press" test was used following the earlier described procedures (Dopsaj and Ivanović, 2011; Ivanović and Dopsaj 2013; Ivanović, 2014). All data was recorded and analyzed using a specially designed software system. The force-time analysis on the absolute scale included the maximal rate of force development as an indicator of the basic (general) level of RFD_{BASIC} expressed in $N \cdot s^{-1}$ defined as the greatest increace in force, in a given necessary time, to reach maximal force; the indicator of specific isometric leg extensors explosive force or the S gradient of the leg extensors force $RFD_{50\%}$, as a rate of force development measured at 50% of Fmax; the indicator of special level of leg extensors explosive force development RFD_{250ms}, measured at time zone of SSC, i.e. at 250 ms of tFmax; the indicator of special level of explosive force development RFD_{180ms}, measured at 180 ms of tFmax; the indicator of special level of explosive force development RFD_{100ms}, measured at 100 ms of tFmax (Čoh, 2010; Dopsaj & Ivanović, 2011; Ivanović & Dopsaj, 2013; Ivanović, 2014; Zatsiorsky & Kraemer, 2006).

Statistical analysis

Definition of the Index of general leg extensors' explosiveness preparedness (RFD_{SCORE}) was made by applying the method of mathematical analogy where the value of position of the factor score of each examined athlete was turned into an analogue point score defined from 0 points (as hypothetical minimum) to 100 points (as hypothetical maximum). In the consequent statistical process of defining a mathematical model the value of the SCORE point represented a criterion variable, while the individual score obtained by application of the battery of all individual tests (5 different characteristics of leg extensors' explosiveness) stood for a system of predictable variables. The final form of the model was defined by application of the Multivariant regressive analysis (Hair et al.,1998). All analyses were done in the statistical package SPSS 12.0.

RESULTS

The results of ANOVA indicated that there were general statistically significant differences in comparison with the index of general leg extensors' explosiveness preparedness (RFD_{SCORE}) between the analyzed groups (at the level of F – 1.642, p = 0.000 for male and F – 8.969, p = 0.000 for female) measured by the method applied.

Applying the multiple regression analysis, specification equations for the evaluation of explosiveness were obtained, regarding the total sample, the different examined sports groups and regarding gender in bilateral conditions of exertion (Dopsaj et al., 2010; Dopsaj et al., 2012).

The criterion variable for the evaluation of explosiveness was obtained by applying a multivariate method of scoring and the result of all individual tests (5 different characteristics of leg extensors' explosiveness – predictive variables) was presented as a unique multidimensional scoring value.

Specification equations for the evaluation of leg extensors' explosiveness regarding the total sample, males:

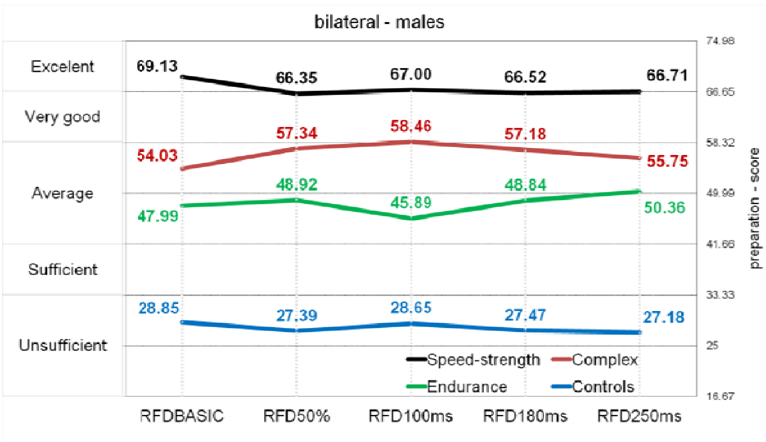
$$RFD_{SCORE} = -2.873073 + (0.001402 * RFD_{BASIC}) + (0.000951 * RFD_{50\%}) + (0.000763 * RFD_{100ms}) + (0.001041 * RFD_{180ms}) + (0.001227 * RFD_{250ms})$$

Specification equations for the evaluation of leg extensors' explosiveness regarding the total sample, females:

$$RFD_{SCORE} = 9.232715 + (0.002238 * RFD_{BASIC}) + (0.001334 * RFD_{50\%}) + (0.0012 * RFD_{100ms}) + (0.001444 * RFD_{180ms}) + (0.001596 * RFD_{250ms})$$

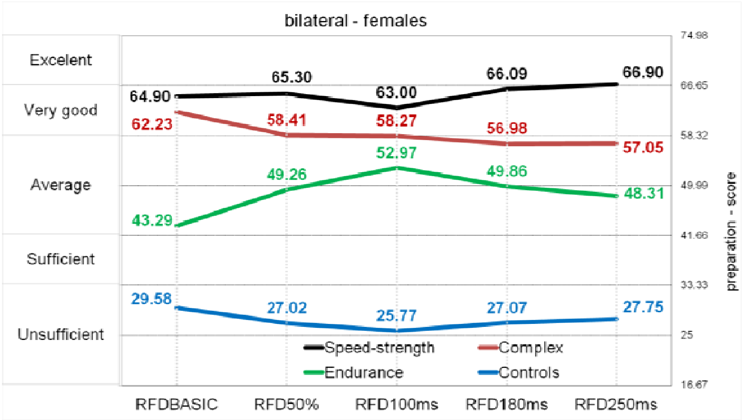
DISCUSSION

Regarding the aforementioned results from the present research study, based on these we can conclude that observed athletes of both genders, and from the different groups of sports, showed a different level of neuromuscular adaptation under the influence of a specific training process, and that these different levels contribute to variations in muscle force and explosiveness production (Graph 1–2).



Graph 1. Classification of groups of sports in relation to the results of partial preparation coefficient – males

Graph 1–2 shows the classification of groups of sports in relation to the results of a partial preparation coefficient regarding different isometric explosiveness indicators in leg extensor muscles measured in bilateral conditions of exertion in males and females.



Graph 2. Classification of groups of sports in relation to the results of partial preparation coefficient – females

The aforementioned indicators clearly show the differences between levels of preparation in relation to different sports groups and untrained individuals. Those differences are visible in both males and females (Graph 1 – 2).

Regarding the preparation level of the tested population and the applied test, the following can be concluded:

- Regarding observed explosiveness indicators in both female and male athletes from the speed-strength sports group preparation in the category very good – excelent was established.
- Regarding observed explosiveness indicators in both female and male athletes from the group of sports with a complex manifestation of all motoric properties the preparation in the category average – very good was established.
- Regarding observed explosiveness indicators in both female and male athletes from the group of endurance preparation in the category average was established.
- Regarding observed explosiveness indicators in unilateral and bilateral conditions of exertion in both female and male untrained individuals preparation in the category unsufficient was established.

From the previous studies on the specificity of moving structure in competitive conditions and on defining time parameters for realizing the most characteristic motor tasks of movement techniques, the following typical time intervals can be isolated: 250 ms as the time necessary to perform the stretch-shortening cycle, 180 ms as the characteristic ground contact time during running in submaximal exertion regime, frequent changes of movement direction and vertical rebounds and 100 ms as ground contact time during running in absolute maximal intensity (Čoh, 2010; Zatsiorsky & Kraemer, 2006). In sports from the speed-strength group and those with a complex manifestation of all motoric properties, which are typical for the realisation of the aforementioned factors, the most common motoric tasks of the motion technique in time intervals of 100–250 ms, the participation of the leg extensor muscles is extremely significant. The time necessary to reach a certain level, and the significance of evaluation for the force increase - explosiveness – is in such sports prominently expressed, and the significance of adequate preparation for leg extensors in the training process is crucial. The results of previous research (Dopsaj, 2010; Ivanović 2014) have shown a significant level of correlation between the sports branch and the production of leg extensors' muscle force in relation to the non-specific trained and untrained population of athletes, for which adoption is most intense at the force level. These differences can be explained by the use of different methods and models for conducting the training process. It is well known that two basic biological mechanisms are of great importance for top-level athletes in training, namely homeostasis and adaptation (Milišić, 2007). Because of long-term training and competition, athletes become adapted to different forms of muscle force manifestation. The fact that in athletes from the speed-strength sports group and sports with a complex manifestation of all motoric properties, where the adaptation is most intensive at the level of force, there exists a significant correlation between the sports branch and explosive force production in relation to the other observed groups, isn't surprising.

Based on defined model characteristics it is possible to compare individual indicators of the training level of athletes who are directly involved in the training process with model characteristics for top-level athletes. In the real world, when planning practice the coach and team professionals must determine the relation between data obtained while testing and the model characteristics of top-level athletes in the selected sports. Based on such analysis the short-term and operational system of athlete preparation can be determined, focusing training work mainly on dimensions in which the athlete lags behind in terms of progress with regard to model parameters.

On a general level, by defining the model characteristics of basic, specific and special levels of explosive force development regarding the leg extensors and in relation to calculated multiple regression models in bilateral conditions of exertion in top level athletes from different sports groups, of both genders, it is possibly to establish a system:

- with the object of diagnostics
  - evaluation of the actual state of an athlete's preparation level,
  - the position of athlete with regard to model criteria,
  - the characteristics of defined changes in the athlete with regard to previous laboratory testing and
  - defining the general improvement tendency with potential prediction;
- with the training process as the object
  - suggesting the following stages of training and
  - prediction of the projects state;
- with the objective of prognostics
  - anticipation of competitive results, i.e. athlete's preparation level.

CONCLUSION

Different explosiveness indicators for leg extensors in both males and females were defined in this research for the sample of 378 examinees. Data on model characteristics for different indicators of leg extensor explosiveness was absent from the available literature, and so the results of this study should provide the most informative indicators. These have the potential to enrich the technological process of managing and monitoring the training level of athletes, so improving control and optimisation of the training process.

Based on the differences in the obtained results with regard to the observed sports groups, a definite influence from the sports branch on the production of explosive force with regard to differently trained athletes, and consequently different forms of adaptation to specific training processes, can be concluded.

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CORRELATION OF RESULTS OF OBSTACLE COURSE FOR ASSESSMENT OF SPECIFIC PHYSICAL ABILITIES OF POLICE OFFICERS WITH MORPHOLOGICAL CHARACTERISTICS AND BASIC PHYSICAL ABILITIES[1]

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SUMMARY

The aim of the work was to establish whether there are any correlations between morphological characteristics and BPA of police officers and the results of job-related fitness test for assessment of specific abilities of police officers (OC_{SAPO1}.). The subjects consisted of 99 men at the average age of 28.1±6.1 with an adequate knowledge and specific physical abilities required for OC_{SAPO1} realization. Morphological characteristic (body height, body mass, body mass index, body fat mass, skeletal muscle mass, body fat and skeletal muscle percentage and protein fat index) had been determined using standardized method with multichannel bioelectrical impedance InBody 720. Basic physical abilities (BPA) had been determined by a battery of tests which included: maximal isometric force of left and right hand finger flexors, maximal isometric force of back and legs extensors and their rate of force development, standing long jump, vertical jump test, time for 15 push-ups, maximal number of pull-ups, number of sit-ups with trunk rotation in 30 seconds, sprint over 30 meters, shuttle run 300 yards test, Cooper running test and Illinois agility test. The results were analyzed by means of descriptive statistics method and application of Pearson's correlation analysis. It was ascertained that between OC_{SAPO1} realization efficiency and morphological characteristics of the men there is highly statistically significant correlation of results (except between total skeletal muscle mass and obstacle course results). Moreover, highly statistically significant correlation of results of Pearson's correlation and the observed BPA was demonstrated. According to the acquired results, it can be deducted that morphological characteristics and the level of BPA development may influence the demonstration of specific motoric abilities of the police officers assessed with OC_{SAPO1} test.

Keywords: police, obstacle course, specific physical abilities

INTRODUCTION

Police work requires a high level of basic physical abilities (BPA) and specific physical abilities (SPA). They represent one of the factors that provide conditions for police officers' efficiency in the course of completion of certain professional tasks (Arvey et al, 1992; Anderson et al., 2001; Vučković et al., 2011). Research has proven that there is statistically significant correlation between physical fitness and the efficiency of accomplishing a segment of police work (Boyce et al., 2008), and also a statistically significant correlation between morphological characteristics, BPA level and the police officer's health has been determined (Sörensen et al., 2000). Thus, it is important to single out physically fit candidates with adequate morphological characteristics and BPA during the selection (Lonsway, 2003). After the selection, the aim of the education is to enhance the level of physical abilities, which can be determined by periodical testing (Dimitrijević et al., 2014).

[1] This paper is the result of the research on project: "Management of police organization in preventing and mitigating threats to security in the Republic of Serbia", which is financed and carried out by the Academy of Criminalistic and Police Studies, Belgrade - the cycle of scientific projects 2015-2019.

Physical abilities testing are mandatory in the course of working career, and the norms defying police officer's competency are determined by sex, age and professional specialization (Vučković et al., 2011; Janković & Dimitrijević, 2012). For the tests to be adequate, the way of testing and establishing of norms must be correlated with the demands of police work. Moreover, there has to be a connection between the tests' results and the actual response requirements of the job (Arvey et al., 1992; Anderson et al., 2001; Lonsway, 2003).

One of the ways to establish and enhance police officers' BPA and SPA is conducting job-related fitness tests (Strating et al., 2010, Jackson & Wilson, 2013). In accordance to earlier research of police work requirements (Anderson et al., 2001) in the research laboratory of Academy of Criminalistic and Police Studies (ACPS) in Belgrade the test – obstacle course (OC_{SAPO1}) for assessment of specific abilities of police officers was constructed (Janković et al., 2014). Earlier studies concluded that OC_{SAPO1}, as an instrument for assessment of specific ability in police officers, is a valid motoric task the realization of which provokes dominant exertion in the zone of anaerobic lactate mechanism of creating energy for the task. In such a state of high level physiological stress, when the level of lactates in blood is over 12 mmol/L, while the heart rate is on the level of over 95% compared to the hypothetical physiological maximum, the subjects were accomplishing the tasks of the SPA field (Dopasaj & Janković, 2014). Specific tasks within OC_{SAPO1} include gun handling, self-defense technique applying and usage of baton and the means of constraint. It was established that the realization efficiency depends on the training quality and, consequently, the level of development of given SPA (Janković et al., 2014). However, the studies so far haven't revealed a correlation between morphological characteristics and BPA with the OC_{SAPO1} test results. Consequently, the aim of this study was to investigate: whether there is a correlation of morphological characteristics and police officers' BPA with the results of job-related fitness test for assessment of specific abilities of the police officers - OC_{SAPO1}.

METHODS

Subjects

In this research the participants were 99 men at the average age of 28.1±6.1 out of who: 30 were ACPS third year students of Security, Criminalistic and Police Department aged 22±1.1 (all of these subjects had received education on subjects Specialized Physical Education, 28 general duties police officer aged 32.4±4.5 with an average working experience of 8.7±4.6 years (all of these subjects were authorized persons that had received educational treatment adequate for police work), 22 subjects of the control group who recreationally practiced martial arts (aikido, karate and the Russian system) with the average age of 26.5±4.9, and the average experience in the sport practice was 3.4±1.3 years of recreational training with the weekly rate of 2.9±0.7 training hours (all of these subjects had had necessary education for solving SPA tasks done within OC_{SAPO1} including 9 school classes of training) and 19 members of Special Anti-Terrorist Unit aged 33.1±4.6.

Procedure

In accordance to the time needed for the realization (t_{SAPO1}) specific ability of a police officer was assessed by OC_{SAPO1} standard procedure (Dopsaj & Janković, 2013; Janković et al., 2014). Morphological characteristics' measurement was conducted within the methodological research laboratory (MRL) at the Faculty of Sport and Physical Education in Belgrade by utilization of body structure analysis InBody 720 by experienced and trained experts in the field of applying the measuring instrument (Umičević et al., 2012). The following morphological characteristics were observed: body height (BH), body mass (BM), body mass index (BMI), body fat mass (BFM), skeletal muscle mass (SMM), body fat and skeletal muscle percentage (%BF i %SM) and protein fat index (PFI). The BPA testing was conducted in the laboratory for basic-motoric abilities assessment at the Academy of Criminalistic and Police Studies in Belgrade. All measures were conducted by using standardized metrologic procedures (Dopsaj et al., 2010). The battery of tests included the following variables: maximal isometric force of left (F_{max}LH) and right (F_{max}RH) hand finger flexors, maximal isometric force of back (F_{max}BE) and legs extensors (F_{max}LE) and their rate of force development ($_{RFD}$LH, $_{RFD}$RH, $_{RFD}$BE, $_{RFD}$LE, respectively), standing long jump (LJ), vertical jump test (VJ), time for 15 push-ups (PU), maximal number of pull-ups (NPU_{max}), number of sit-ups with trunk rotation in 30 seconds (ABD), sprint over 30 meters (30m), shuttle run 300 yards test (SH_{300}), Cooper running test (CT) and Illinois agility test (IA_{test}).

Statistical analysis

In the first step of data analysis, the method of descriptive statistical analysis was applied by the means of which the following parameters were calculated: arithmetic mean ($\bar{X}$), standard deviation (SD), standard error of arithmetic mean (sx), coefficient of variation (cV), minimal and maximum value of each observed variable (Min, Max), the indicator of the degree of skewness of the results – coefficient of skewness (Skew) and the indicator of the degree of kurtosis – coefficient of kurtosis (Kurt). In the further data analysis process, methods for causality assessment between the observed features were used. The correlation between the variables was calculated applying Pearson correlation analysis (Hair et al., 1998). All statistical analysis was done by the application of software package SPSS for windows, R. 22.0.

RESULTS

Table 1 depicts all results of descriptive statistic of realization efficiency of OS_{SAPO1} and all observed variables of BPA of the tested subjects.

Table 1. Results of descriptive statistic OS_{SAPO1} and BFA

	$\bar{X}$	SD	Max.	Min.	Skew.	Kurt.	cV	Sx	sx%
t_{SAPO1}	88.29	10.61	120.43	61.45	0.23	0.39	0.12	1.05	1.19
$F_{max}LH$	49.76	7.88	70.10	31.60	0.24	-0.28	0.16	0.78	1.57
$_{RFD}LH$	47.42	22.72	143.17	12.20	1.41	3.17	0.48	2.25	4.74
$F_{max}RH$	53.66	7.26	75.30	37.80	0.31	0.57	0.14	0.72	1.34
$_{RFD}RH$	48.16	21.37	118.58	13.29	0.87	0.30	0.44	2.12	4.39
$F_{max}BE$	159.58	19.54	226.50	113.70	0.30	1.08	0.12	1.94	1.21
$_{RFD}BE$	66.12	21.44	137.05	33.42	0.97	0.91	0.32	2.12	3.21
$F_{max}LE$	155.60	20.51	225.00	101.80	0.22	1.09	0.13	2.03	1.31
$_{RFD}LE$	66.48	22.92	153.37	30.69	1.57	3.11	0.34	2.27	3.41
VJ	40.36	6.33	56.00	22.60	-0.04	0.06	0.16	0.63	1.55
LJ	223.14	20.52	267.00	145.00	-1.31	3.24	0.09	2.03	0.91
ABD	26.12	4.71	33.00	10.00	-1.28	1.81	0.18	0.47	1.79
NUP_{max}	11.59	7.67	32.00	0.00	0.27	-0.54	0.66	0.76	6.55
PU_m	13.15	2.91	23.50	9.64	1.62	2.38	0.22	0.29	2.19
30m	4.66	0.24	5.35	4.12	0.36	0.15	0.05	0.02	0.51
SH_{300}	66.64	5.14	86.65	57.79	1.57	3.75	0.08	0.51	0.76
CT	2484.08	343.24	3600.00	1680.00	0.14	0.33	0.14	33.99	1.37
IA_{test}	19.04	1.60	25.04	16.55	0.98	2.28	0.08	0.16	0.83

t_{SSP1} (sec.); $F_{max}LH$ (DaN); $_{RFD}LH$ (DaN/sek); $F_{max}RH$ (DaN); $_{RFD}RH$ (DaN/sec); $F_{max}BE$ (DaN); $_{RFD}BE$ (DaN/sec); $F_{max}LE$ (DaN); $_{RFD}LE$ (DaN/sec); VJ (cm); LJ (cm); ABD_m (No.); NUP_{max} (No.); PU_m (sec.); 30m (sec.); SH_{300} (sec.); CT (m); IA_{test} (sec.)

Table 2 depicts results of descriptive statistics of all observed morphological variables of the tested subjects. Table 3, Table 4 and Table 5 depict results of Pearson's correlation between the time needed for OC_{SAPO1} realization, observed morphological characteristics and BPA of tested subjects.

Table 2. Descriptive statistic of morphological characteristics result

	$\bar{X}$	SD	Max.	Min.	Skew.	Kurt.	cV	Sx	sx%
BH (cm)	181.23	5.62	196.50	166.10	0.24	0.48	0.03	0.56	0.31
BM (kg)	85.56	11.91	145.90	59.00	1.17	5.59	0.14	1.18	1.38
BMI (kg/m^2)	26.01	3.08	40.42	19.00	1.04	4.50	0.12	0.30	1.17
BFM (kg)	14.77	7.65	56.60	4.90	2.20	8.51	0.52	0.76	5.13
SMM (kg)	40.40	4.40	52.10	29.80	0.29	0.09	0.11	0.44	1.08
%BF	16.73	6.38	38.79	6.10	1.07	1.21	0.38	0.63	3.77
%SM	47.54	3.90	54.46	34.96	-0.86	0.69	0.08	0.39	0.81
PFI	1.17	0.51	3.04	0.31	1.02	1.48	0.44	0.05	4.35

Table 3. Results of Pearson's correlation between the time needed for OC_{SAPO1} realization and observed morphological characteristics

		BH (cm)	BM (kg)	BMI (kg/m^2)	BFM (kg)	SMM (kg)	%BF	%SM	PFI
t_{SSP1} (sec.)	P. Corr.	0.228^{*}	0.273^{**}	0.205^{*}	0.465^{**}	-0.055	0.472^{**}	-0.458^{**}	-0.327^{**}
	Sig.	0.023	0.006	0.042	0.000	0.590	0.000	0.000	0.001

** Correlation is significant at the level of 0.001
* Correlation is significant at the level of 0.005

Table 4. Results of Pearson's correlation between the time needed for OC_{SAPO1} realization and observed BPA form the aspect of maximum isometric and explosive force

		F_{max}LH (DaN)	$_{RFD}$LH (DaN/sec)	F_{max}RH (DaN)	$_{RFD}$RH (DaN/sec)	F_{max}BE (DaN)	$_{RFD}$BE (DaN/sec)	F_{max}LE (DaN)	$_{RFD}$LE (DaN/sec)
t_{SSP1} (sec.)	P. Corr.	-0.233*	-0.059	-0.122	-0.150	-0.354**	-0.244*	-0.356**	-0.247*
	Sig.	0.020	0.564	0.228	0.139	0.000	0.015	0.000	0.014

** Correlation is significant at the level of 0.001
* Correlation is significant at the level of 0.005

Table 5. Results of Pearson's correlation between the time needed for OC_{SAPO1} realization and observed BPA form the aspect of speed and repetitive force, maximum running speed, anaerobic and aerobic stamina and agility

		VJ (cm)	LJ (cm)	ABD (No)	NUP_{max} (No)	PU_m (sec.)	30m (sec.)	SH_{300} (sec.)	CT (m)	IA_{test} (sec.)
t_{SSP1} (sec.)	P. Corr.	-0.346**	-0.443**	-0.640**	-0.554**	0.522**	0.407**	0.612**	-0.581**	0.569**
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

** Correlation is significant at the level of 0.001
* Correlation is significant at the level of 0.005

DISCUSSION

The results of the Pearson's correlation indicate that there is a highly statistically significant correlation of results between OC_{SAPO1} realization efficiency and morphological characteristics (Table 3). It was estimated that BH, BM, BMI, BFM and %BF statistically significantly influence t_{SSP1} in a negative way, while the positive correlation of the result was found between t_{SSP1} and %SM. Only between SMM and t_{SAPO1} no statistically significant correlation was found. High statistically significant correlation of the results of Pearson's correlation between BPA and OC_{SAPO1} realization efficiency was determined within all the tests except for $_{RFD}$LH i $_{RFD}$RH (Table 4 i Table 5).

Earlier studies have confirmed the assumption that in the case of police officers there is positive correlation between morphological characteristics and BPA (Arvey et al., 1992). It has also been demonstrated that the speed and quality of acquiring judo technics (which are considered as SPA of police officers) in different phases of the training are significantly influenced by morphological characteristics and BPA (Blagojević, 1996). The existence of significant correlations between the gun shooting results and the POPAT test results, the size of the forearm and the hand grip has also been determined (Anderson & Plecas, 2000). One of the factors influencing BPA and morphological characteristics development is the time dedicated to training. Strating and associates (2010) had a goal to determine what physical requirements are included by doing police work, and, in accordance to the results, to conduct a standardization of a test for assessment of physical abilities of the Dutch Police. PCT was used in this occasion, body mass index was measured, and data on frequency of physical exercise was collected by means of a questionnaire. The results of the study showed that the test result correlates with the body mass index and the time the police officers spend doing physical exercises. Pearson's correlation indicated that BMI and the number of hours of physical exercise per week are statistically significantly correlated. However, the Jackson & Wilson research (2013) showed that the GeNTOC test norm is passed by 42% of overweight and 7% of obese police officers. Based on these results, it is concluded that GeNTOC comprises of a proper content as far as specific physical abilities measurement is concerned, but that it cannot be used a selective model due to the afore-mentioned number of overweight candidates that passed the test. However, on the basis of BMI a high number of overweight employees of the emergency services can be identified, so it is recommended that this variable should be one of the criteria used to determine adequate morphological characteristics (Vanderburgh, 2008).

The results of this research determined that the result of the obstacle course positively correlates with the skeletal muscle percentage best, while a negative correlation was found among the total body fat amount and its relative value (Table 3). Taking BPA into consideration, the largest positive correlations between t_{SAPO1} and ABD, SH_{300}, CT and IA_{test} tests were found (Table 5). In other words, the results indicate that it is favorable that the skeletal muscle percentage and body fat percentage are taken as selective criteria within morphological characteristics of police officers. Moreover, during selection and inspection of BPA of police officers, it would be adequate to select candidates with higher level of aerobic and anaerobic stamina, repetitive power of the trunk flexor muscles and better results in agility tests.

CONCLUSION

The research, with 99 subject of different professional specialization, demonstrated that there is a high statistically significant correlation between the results of job related fitness test for assessment of specific ability of police officers and basic morphological characteristics and BPA. According the acquired results of correlation analysis, we can conclude that the OC_{SAP01} realization efficiency, beside SPA level of development, can depend on morphological characteristics, as well as BPA development level. The obtained results can be used in the choice of tests for assessment of morphological characteristics and BPA of police officers both as means of selection and in the course of the police officers' working career.

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IMPLEMENTATION OF THE NEW SOFTWARE APPROACH OF LEARNING ENGLISH OF THE POLYTECHNIC UNIVERSITY WATERPOLO TEAM MEMBERS

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Key words: English, sports terminology, professional communicative competence

Today, English has penetrated in all spheres of human life. For quite a long time, it is an international language and the official language of international competitions. English has gained universal acceptance and recognition through the trade, economics, business, computer engineering and sport. An important role in this system belongs to the language and formed on this basis, professional and business vocabulary and terminology, providing capacity for professional communication.

It is known that many sports were originated in England (badminton, tennis, rugby, etc.). Water polo was not an exception. In the 1800s in the water competition between England and Scotland"aquatic football" was invented, which eventually turned into a "water football," and end up in water polo.Water Polo Rules were developed and compiled by William Wilson (Scottish journalist and swimming coach) onlyin 1870.

Today, water polo is on a par with global sports such as hockey, football, basketball. It is an Olympic sport. Every year the championship and water polo competitions are hold on the world and regional levels.

On the basis of the St. Petersburg Polytechnic University, there are university teams in football, volleyball, basketball, hockey, etc., but water polo team- a visiting card "Politehnica". Young people-students of the Polytechnic University defend the honor of the University of competitions at various levels-including international ones.

With the rapid developmentof the program "5-100-2020", foreign partners will appear at the Polytechnic University, which would entailan active cooperation not only in the academic field but also in sports.

In connection with these students-athletes need additional knowledge in mastering sports terminology in English. Therefore, an experiment was conducted, consisting of several stages.

In the first stage, based on specialized vocabulary of sports terms[2] has been developed and produced educational and handouts to self-study, the computer programto test the knowledge, skills test to check the conversation and use of new vocabularyin a situation of communication.

In the second stage student-athletes was given handouts (lists of terms with a translation and transcription; phrase-pad) for the self-work. Also, there have been several studies on the analysis of the material, to facilitate the task in the perception and understanding of the material by students.

At the third stage testing was conducted to check the knowledge of students-athletes with a specially created computer programin the form oftest (all terms and offers cues with the terms of the testare subject to sound processing). The use of recording increases the perception ofthe adequacy and speed of learning material that makes it possible to transfera significant amount of knowledge and skillsin the shortest time and at low cost effort. The strength of knowledge, thanks to the possibility of multiple repetition, can be significant. Also, the second part of the test is an oral practice: application of knowledge in communication (conversation with the judges, members of other teams, the organizers of the competition, and others.)

In the fourth stage,we summed up the test results, which showed the level of received material by student-athletes.

The aim of our research was to determine the effect of the programmed approach to teachinga foreign language through intensive courses adapted for team sportp layers, using the posteriori computerized test.

Consider the possibility of usinga variety of tests conducted on a computer, and programs that help to work with databasesas an example of progress of individuals.

With the help of testing knowledge can be identified, in this case, the player of a sports team, the ability of the first stage properly respond to indications of coaches and referees in English, the second stage to carry on dialogue with partners, and the third -the final stageto be able to conduct analysis of the game and answer the questions of the interviewer. This test can be implemented on a computer by means of software and hardware simulation. For the implementation already existingtexts of such programs can be used for adapting the desired format. C ++language can be selected for the implementation.

The use of the computerized approach (audio recording) allows to optimize the procedure for of testing the knowledge of learners, having a number of advantages:

1. Accelerating the testing procedures: Training can be tested jointly or one at a time, with out interfering each other.
2. Ergonomics procedure: testing can be performed online, on the website or in the offline mode -with the help oft he developed software.
3. Increase of the speed and quality of assessment procedures of test results, as well as checking their [the results] reliability, due to the automation of the process thus exclude the human factor.
4. Improving the efficiency of coaches: the teacher will no longer spend time holding the intermediate stages of work (counting points the results , a survey of players, etc.) and will be able to spend more time analyzing final statistical information and make adjustments in the learning process of each athlete individually.

With regard to the particular case of a contingent of learners, namely, a sports team players, you can designatea specific individual advantages of programmed approach of learninga foreign language:

Proper adequate response to the indications of of coach referee in English. Concise and informative conducting dialogue with teammates and rivals in English. The absence of the language barrier in the analysis of the game and in the conversation with the interviewer.

The computer program testing may be implemented on a wide varietyof programming languages. We have used the language C ++.

The main"filling"of the test, of course, is a list of questions, which can be either sewn in to the program code, written in any document used by the program, which is carried out by means of testing. In the latter case, the test program becomes more versatile, as the changes or additions to the list of questions is not required to change the program code, but only the file containing the questions. For the list of test questions can be used ready-made texts of similar programs, adapted to the proposed programmed approach.

Thus, the educational experiment conducted by us with three groupsof athletes of different levels of language proficiency –through the special units of created problems for the different groups of athletes and stream lined general algorithm of passing the test results allowed to obtaina very high levelof informativeness and reliability with minimal time spent.

Therefore, teaching of foreign languages is important as during school hours in the classroom, standing in the curricula of the Polytechnic University as well as in the facultative form in sports team of the University . In this work a technique of training of sports specialized terminology was tested on student-athletes from the national team of the Polytechnic University water polo.

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NON CELIAC GLUTEN SENSITIVITY AND SPORT PERFORMANCE

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SUMMARY

NCGS (earlier define as gluten sensitivity or non celiac intolerance) is new and offten unrecognized clinical entity wich can affect sport performance. NCGS can cause bloating, abdominal discomfort or pain, constipation and diarrhea. Sensitivity may also present with extra intestinal symptoms, including headache, "brain fog", tingling and/or numbness in hands and feet, fatigue, as well as muscular disturbances and bone or joint pain. Epidemiology of non-celiac gluten sensitivity is not clear and the incidence of NCGS is unknown; some epidemiological data estimates range from between 0.5% and 13%. The aim of our research is to evaluate awareness of students Faculty of sport and physical education about this health issue.Research was conducted in 2014. at the Faculty of sport and physical education, Nis. The questionnaire was filled in by 60, (the 2nd year) students. Our results show that 93% students of Faculty of sport and physical education haven't heard about NCGS. Of 7% students who have heard about this clinical entity 34% don't know any of disease symptoms, 15% of students know two NCGS symptoms, 51 % dont' know any of NCGS symptoms or they wrote wrong symptoms and only 10% students know that this disorder may have impact on sport performance. Our results show that there is a lack of awareness among the students of Faculty of sport and physical education about this clinical entity which have potential to impede sport performance.

Keywords: gluten sensitivity (intolerance), athletes, sport performance, students awareness

INTRODUCTION

Non celiac gluten sensitivity (earlier define as gluten sensitivity or non celiac intolerance) is new and offten unrecognized clinical entity defined for the first time as gluten sensitivity in 2011. at the First expert meeting (Sapone et al., 2012), later, a group of 16 experts annonced and suggested new definition (the Oslo definition) for GS (Ludvigsson et al., 2013). In 2012. at the Second expert meeting in Munich new syndrom gluten intolerance was named NCGS (Capili, Chang, & Anastasi, 2014). More than 250 symptoms of gluten sensitivity have been reported, including bloating, abdominal discomfort or pain, constipation and diarrhea. Sensitivity may also present with extra intestinal symptoms, including headache, "brain fog", tingling and/or numbness in hands and feet, fatigue, as well as muscular disturbances and bone or joint pain. (Biesiekierski et al., 2011);(Sapone et al., 2012);(Di Sabatino & Corazza, 2012). Most of the symptoms are subjective, without clinical signs, and there is no specific biomarkers for early diagnosis (Volta et al., 2012), of this clinical entity witch could be unrecognized for long period. The aim of our research is to evaluate awarnes of Faculty of sport and physical education students about this health issue.

METHODS

Reaserch was conducted in 2014 at the Faculty of sport and physical education , Nis. Our survey was conducted in summer semestar 2014. The questionnaire was filled in by 60 students. We divided students by gender and age. Our reaserch included 55 male students and 5 female second year students average age 20±1. The poll contained questions about informed, partial informed and total lack of information about gluten sensitivity impact on sports performance.

The questions were as follows:

1. Have you heard about gluten sensitivity syndrome?
2. Do you know to enumerate some of the symptoms gluten sensitivity or intolerance?

3. Do you know that gluten intolerance can effect sport performance?

Statistical analysis

All statistics were done using the SPSS statistical software version 13 (SPSS, Chicago, IL, USA) and statistical software MedCalc version 9.0.1.Results are shown in percents, in table and chart.

RESULTS

Our results show that 93% Faculty of sport and physical education students haven't heard about NCGS. Of 7% students who have heard about this clinical entity 34% don't know any of disease symptoms, 15% of students know two NCGS symptoms, 51 % dont' know any of NCGS symptoms or they wrote wrong symptoms and only 10% students know that this disorder may have impact on sport performance.

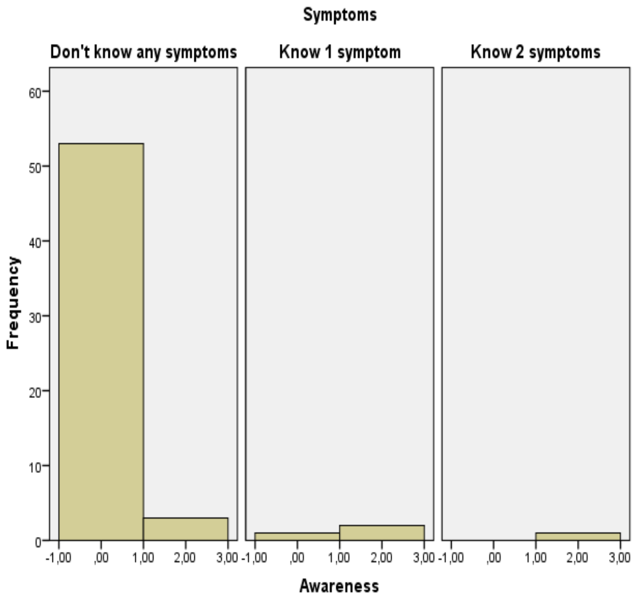

Figure 1. Students awareness(frequency)

Table1. Students awareness (frequency)

	A	B	C
Awareness- yes	3(10%)	2(34%)	1(15%)
Awareness- no	57 (90%)	0	0

A- 0 symptom
B- 1 symptom
C- 2 symptom

DISCUSSION

Our results show that there is a lack of awareness among the 2nd year students of Faculty of sport and physical education about this clinical entity (Rossi et al.). In the last few years we are witnesses of the steady increase of interest for this new clinical disorder with potential to impede sport performance. Epidemiology of non-celiac gluten sensitivity is not clear and the incidence of NCGS is unknown; some estimates range from 0.6% to 6%,(Czaja-Bulsa, 2014) and a systematic review published in 2015 reported on studies with NCGS prevalence rates between 0.5% and 13%(Molina-Infante, Santolaria, Sanders, & Fernández-Bañares, 2015).There is no statistical data about disease prevalence among athletes. To data there are contradictory literature data about this health problem and real benefit of GFD (gluten free diet) on health and there are insufficient literature data to explain disease pathology. We think that better FSFV students' knowledge on this disorder might help them to early recognize symptoms that could influence on their sport performance.

D.Lis et al. are showed in their study that a short-term GFD had no overall effect on sport performance and well-being in non-celiac endurance athletes.(D. Lis, Stellingwerff, Kitic, Ahuja, & Fell, 2015). D.M Lis et al. are highlighted in ther reaserch that prescription of a GFD among many athletes does not result from evidence-based practice suggesting that adoption of a GFD in the majority of cases was not based on medical rationale and may be driven by perception that gluten removal provides health benefits and an ergogenic edge in NCA(D. M. Lis, Stellingwerff, Shing, Ahuja, & Fell, 2015). However Di Sabatino et al. In a cross-over trial of subjects with suspected NCGS suggested that gluten may impact on sport performance during 1 week of intake of small amounts of gluten, compared with placebo. (Di Sabatino et al., 2015). Our famous tennis player Novak Đoković improved his sport performance after gluten withdrawal but this is only case report.

CONCLUSION

Until the noninvasive methods became available to assess physical performance in individulas with NCGS giving definitive answer whether gluten frree diet influence on sport performance we should be aware about potential health disturbances caused by this clinical entity. Since there is no specific drug to cure this disease early diagnosis and disease detection along with gluten free diet are the most effective way to cope with symptoms with potential to influence on sport results.

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SITUATIONAL SUCCESS IN VOLLEYBALL: REVIEW

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SUMMARY

How successfully a certain game situation will be resolved largely depends on the relationship between the players, the choice of tactics and the professional attitude of the players towards the game. Achieving excellent results in volleyball is impossible without adequate informing, the implementation of scientific research and modeling trained state of athletes, the training process and competitive activity.The aim of this study was the analysis of the collected researches to show how important efficiency is for improving performance in volleyball. The study included 21 papers.The results of the analyzed papers show that the elements of competitive activities have a key role when it comes to improving the training process as well as the competitiveness of volleyball players. The training process should include the work on the development of technical and tactical elements necessary for competitions.

Keywords: Volleyball, Technical and tactical elements, Analysis of competitive activity, Efficiency.

INTRODUCTION

Top results achieved in volleyball stem from a number of factors different in their nature (biological, psychological, social and anthropological). The ground point from which the training process should be taken to the next level by incorporating science and scientific methods into the planning and programming processes as well as training management and the achieved effect evaluation is the analysis of the competitive activities of volleyball players. Team success largely depends on team work, the coach- player interaction, management skills of the coach, mutual relationships among the players on and outside the court, that is, the overall dynamics of the group. Team members should build mutual interaction, work towards the same goals, adapt to the requirements of their surroundings and their position in their team, and create the balance between their personal needs and the aspirations of their team. A heterogeneous group, such as a team at the beginning of the training process, should slowly be transformed into a homogenous, coordinated unity which functions efficiently driven by the desire to win because 'a sports team is not a fellowship of the best individuals but a fellowship of individuals that function in the best way as a unity (Koprivica, 1998). The main problem of each coach is to enhance the efficiency of the individual technique of each player in specific situations and to raise the quality levels of the realization of the individual and team tactics in competitions. Scientific researches in sport should reveal new facts that would complete the current systems of knowledge. Such knowledge is necessary so that each individual activity could be fully understood. This understanding reveals the meaning of sport. The parameters used for evaluating situational successfulness are gathered in major competitions. The reason for this is the fact that there is an established method of registration certain parameters in games and throughout the whole competition ompetitive activities in games are analyzed by watching the recording of the game. A certain number of training games are recorded during the preparatory period and the following parameters are marked for each team member: the number of technical and tactical elements used in the game, how often certain elements are used in the game, the percentage of the successful usage of relevant elements and the scope and the intensity of movement (Dopsaj, 1994).

Aim

The aim of this paper was to represent the analysis of the researches into situational success in volleyball from 2000 to 2015.

METHODS

Descriptive method and theoretical analysis were used for gathering, classifying and analyzing the relevant related researches found via Google, Google

Scholar, PubMed and Kobson. Additional references, such as course books, were also used. The limits to the web browsing were set to all the situational success in volleyball papers published from 2000 to 2015. All the analyzed scientific researches were published in the magazines with the significant impact factor. The following key words were applied: volleyball, technical and tactical elements, competitive activity analysis and efficiency. We also tried to find more relevant researches by reading the references of all the papers.

RESULTS

Table1 shows, in chronological order, all the researches into situational success in volleyball, which, afterwards, underwent further analysis. Each paper represented consists of the following parameters: the set of the examinees, the analyzed parameters and the results. The total number of the analyzed papers is 22. Six papers were on the analysis of the attack and the counter attack as the key success factor in volleyball (Patsiaouras et al., 2011; Guo et al., 2001; Rocha et al., 2006; Mesquita et al., 2007; Marelić et al., 2004; Gabbett et al., 2006; Palao et al., 2006). Six papers were on serve and reception as success indicators (Patsiaouras et al., 2011; Marelić et al., 2004; Gabbett et al., 2006; Lidor et al., 2007; Fialho et al., 2006; Agelonidis et al., 2004). Among the analyzed papers there were a few with the aim to examine the influence block had on success in volleyball (Patsiaouras et al., 2011; Lobietti et al., 2006; Marelić et al., 2006). Three papers dealt with literal and factoral data (Huang et al., 2001; Sloan et al., 2005). Only one research within this review analyzed motor activity of the setter (Hernandez et al., 2004). Two papers examined the way contextual interference could improve motor and technical abilities as well as the extent to which it influenced success in volleyball (Jones et al., 2007; Zetou et al., 2007).

Table 1. Chronological representation of the gathered and analyzed researches

REFERENCE	SET OF THE EXAMINEES	PARAMETERS ANALYZED	RESULTS
Huang et al. 2001.	Cuban female team	Literal and factoral data; statistics; experts' opinions	The superiority of the Cuban female volleyball players depended on their physical capacity, versatile techniques and tactics and the power of attack and block.
Vernadaki et al. 2002.	32 pupils	Comparative analysis between traditional methods of teaching technique and teaching aided by multimedia	No statistically significant differences in the efficiency of the acquired skills
Marelić et al. 2004.	Male and female volleyball players of the First A Italian League	Serve, reception, attack spike, block and counterattack spike in 76 sets of 20 games	The results showed the highest discriminative value of the following variables: attack spike, counterattack spike and reception. The lowest discriminative value was noted in block and serve.
Agelonidis 2004.	Participants of prestigious tournaments	The prominence of serve jump in the period of 10 years (from 1992 to 2002)	The results showed the rise in the prominence of jump serve from 20.8% to 99.2%. The results also showed that only in 28.2% the opponent managed to organize the first tempo attack after the jump serve.
Sloan 2005.	Volleyball team coaches	The possibility of using CD-ROM for perfecting the coach's ability to perform the qualitative analysis of serve	The results showed no difference between the traditional methods of coach training and the innovative one.

Palao et al. 2005	Male and female volleyball players , the participants of the finals of the 2000 Olympics	4968 actions in 33 games (male players); 2450 actions in 23 games (female players); the effect of the previous actions and the field game on the spike efficiency	The team with a good reception sped up the game intending to diminish the opponent's ability to organize defense efficiently.
Palao et al. 2006.	Male and female volleyball players , the participants of the finals of the 2000 Olympics.	4968 actions in 33 games (male players); 2450 actions in 23 games (female players); the type, the zone and the direction of the spike	The position of the setter was balanced in male volleyball, whereas in female volleyball it was better if the setter was on the second line.
Gabbett et al. 2006.	26 junior volleyball players	Eight-week-long work on crossing, setting, serving and spiking	Significant improvement in precision was shown except for the serve.
Gabbett et al. 2006.	26 junior volleyball players	Morphological parameters (height, reaching height, body mass and seven skin creases). Motor parameters (strength, speed, agility)	Significant improvements in speed and agility
Fialho et al. 2006.	10 top male volleyball players	The influence of contextual interference on perfecting service technique	Variety of motor programmes could help improve learning even of top players
Rocha et al.2006	Brazilian senior male team	3471 attack sequences in 77 games	The obtained results showed that the outcome could be predicted in 77.92% of the cases from the efficient block The obtained results showed that the outcome could be predicted in 77.92% of the cases from the efficient block
Nešić et al. 2006.	Top female volleyball players who took part in European Championships in 2001, 2003 and 2005	Jumps, active and passive game time and spiking in 48 games.	A high level of physical preparations influences the outcome in 73,76%
Lobietti et al. 2006.	16 women and 15 men, all members of the Italian League	Footwork in blocking the opponent's counterattack	The results showed that the female players used a large number of steps, pertaining to the slide step, whereas the male players preferred the crossover step.
Mesquita et al. 2007.	The participants of the qualifications and the finals of the 2007 World's League	960 defensive actions recorded in 33 sets in the World League qualifications: the defense intervention zone, the counterattack zone, spiking tempo, defense efficiency, the efficiency of passsing the ball and counterattack efficiency	The results showed that after the reception by libero there was a higher possibility of speeding up the game tempo and of preparing attack better.
Lidor et al. 2007.	15 top male volleyball players and 11 high – ranking male volleyball players	The way in which fatigue influenced technical and tactical element performance	The results showed that there was no significant influence of fatigue on the precision of the serve.
Jones et al. 2007.	Students divided into two groups	Improving motor abilities with the aid of contextual interference method	Both groups showed progress in acquiring this technique; there was no significant difference between the two methods used in teaching
Zetou et al. 2007.	26 female volleyball players at the beginner's level	The influence of the high and low levels of contextual interference on the efficiency of the training process as well as on perfecting the technique	There was progress in acquiring technical elements. The progress was identical in both approaches.
Patsiaouras et al. 2011.	The teams of 2008 Olympics Finals	Serve, reception, attack and block.	The results showed that the most influential parameters were serve, reception error and block efficiency.

DISCUSSION

The researches into the efficient performance of technical and tactical elements and their interdependance dealt with the way efficient reception and field game influenced performance and efficient spiking. The order of the actions in volleyball is usually cyclic or sequential so it is logical to suppose that the efficiency and quality of the former actions influence the latter ones. Palao, Santos & Urena, 2006 conducted a research into the efficiency of technical and tactical elements performance and their mutual relationship. They analyzed the influence of the efficient reception and the field game on the way spike was performed and its efficiency. The sample was comprised of 4968 actions recorded in 33 games of the male national team and 2450 actions in 23 games of the female national team that participated in the 2000 Olympics. The researchers examined the effect the reception and field game had on the attack tactics. The results showed that the team that had a good reception would speed up the game tempo leaving no time for the opponent to prepare the efficient defense. However, the prominence of certain technical and tactical elements changed over time. The prominence of the serve jump was observed over a 10-year-period, that is, from 1992 to 2002. Six tournaments and 23 games were included into the research, along with 4338 serves that were subsequently analyzed. During that period, the prominence of the serve jump rose from 20.8% to 99.2%. Such a dramatic rise in the prominence of the serve jump could be explained by the stronger effects this way of serving had entailing a larger number of aces and reducing all the chances of organizing the efficient counterattack. All the advantages that this type of serving has overcame the large risk of the server's mistake. The results presented in the research by Agelonidis et al., 2004 showed that only in 28.2% the opponent managed to organize the first tempo attack after the jump serve. The percentage was 49.3 after the usual way of serving. When it came to technical and tactical activity during the game, the activity anticipation, including both the opponents and one's own had a special significance. That was observed in the activity of the setter, whose motor activity could, to a greater or lesser extent, signal to both his own and the opponent players where the ball would go. The research analyzed 36 randomly chosen activities of two top setters examined by cinematic method and photogrammetry. From the results, the authors concluded that the angles of the setter's body could enable the prediction of the choice of the setter's tactic (Hernandez et al. 2004). The comparison of the tactical and technical element performance techniques in male and female players was also the subject of certain researches. The footwork techniques when blocking the opponent's counterattack in male and female players were analyzed on 16 women and 15 men, all members of the Italian League. The researchers identified seven footwork techniques (slide step, crossover step, vertical jump, repeated slide, crossover slide, slide-crossover slide and run). It was concluded that the female middle block used a lot more steps and the outer block more slide steps than male blocks, who preferred crossover steps as their basic footwork technique. The authors ascribed those differences to the shorter time interval blocking required, for which motor potentials in capacity were needed, something female players could not perform (Lobietti & Merni, 2006). Improving motor skills through contextual interference method became recognized in the 90s of the last century. However, it is still not quite possible to make generalizations about the effects this method has on learning. An interesting field of research is into the number of repetitions and motor task changes. A research into contextual interference was conducted to show how efficient that method would be when it came to acquiring and preserving three volleyball techniques. Students were divided into groups, some of which underwent structural series trainings and others trainings that included random task changes in blocking. Both groups showed significant improvements in acquiring and achieving efficiency in volleyball element performance. However, the authors did not find the significant difference that would prove contextual interference method superior to others (Jones & French, 2007). Among significant psychological factors that have a great influence on the ways a volleyball team performs, which, in turn, has a great influence on the result of the game, the most significant ones certainly are the following: instructions before the game, specific warming-up, the decisions made before the game – serve or reception, team management during the game, breaks during the game (time-out uses and player changes during the game), breaks between sets, tempo and rhythm of the game, the coach's behaviour before, during and after the game (Nešić, 2001). Chinese researchers (Guo & Zhang, 2001) analyzed the effects of the attack tactics in female volleyball. The comparative analysis of the attack tactic characteristics among the teams of Brazil, Russia and the USA showed that female Chinese team lacked efficiency, except for fast attacks. Those fast attacks were the positive side to be focused upon in further team preparations. The final volleyball tournament held in the Olympic Games in Beijing in 2008 was analyzed with the aim of getting the information on the technical elements that strongly influenced the outcome of the game. To obtain the necessary data, 29 matches were recorded and the following parameters analyzed: serve, reception, attack and block. The data processing techniques were non-parametric statistical ones due to the size of the sample and deviations from standard distribution. The results showed that the most influential parameters were serve, reception error and block efficiency (Patsiaouras, 2011). The attempts to strengthen the defense potentials of the team resulted in introducing the position of libero. A research with the aim of justifying the introduction of the position of libero whose task would be to amplify the defensive potential of the team was conducted. The researchers analyzed 960 defensive actions recorded in 33 sets in the World League qualifications. Its variables were: the player who intervened in defense (libero or any other), the zone of defense intervention, the zone from which counterattacks were performed, spiking tempo, defense efficiency, passing efficiency and counterattack efficiency. The results showed that after the reception by libero there was a higher possibility of speeding up the game tempo and of preparing attack better. The research did not show any connection between the defense player (libero or any other player) intervention and the attack zone, the number of the defense blocks and counterattack efficiency. In conclusion, the authors made functional connections between defense interventions and higher defense efficiency and fast attacks (the second tempo), whereas the intervention on the side of libero did not have any influence on the counterattack quality (Mesquita et al. 2007).

CONCLUSION

It is clear that without a detailed research into and analysis of both training and competitive activities it would be impossible to solve the problem of the successfully modeled training process and competition. The importance of the situational training and competition modeling is in that anyone who tests and measures volleyball player in laboratory conditions or in any other empirical way will not be able to provide the answer whether or not that player is adequately prepared or whether they can successfully achieve the wanted result without the direct situational parameters, norms, analyses and predictions. A mere mechanical application of certain training models will not bring about the desired result. Only on the grounds of the competitive activity analysis can a training process and a game be planned. In other words, in volleyball, a training process should closely follow the real game. The knowledge of the competitive activity structure can improve the training process and competition preparation of volleyball players. What needs to be done is to pay particular attention to the development of those technical and tactical elements necessary for achieving success in competitions.

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