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Do, or do not. There is no 'try' !
(Yoda – 'The Empire Strikes Back')

Dear reader,
'Images' of our wishes and acting in science always reflects in two ways. One is operative with comprehension application in real life, and the other is accumulation of total knowledge for which we do not have to be sure when, where and how it will be vivified. Under expressed needless pressure for maximal faster knowledge application today we often loose from sight that many of such knowledge are not verified enough and can cause several disturbances and problems in long-term behavior. That fact worth for all areas of human acting and for all scientific disciplines. Accordingly, morality of our acting will made future times just that as we can seen them today, because our future is sown today, and even more, some of its segments much earlier – in our history. From such point of view, complete human race comprehensions are not, and could not be limited on one little segment, meaning - such one when we live. Consequently, to ensure that we can be absolutely clean behind our 'me', in science we have to stand brave, resolute and proud. It is not acceptable to comply afore aggressive, positivistic, and in essence in front superficial 'marshal' that tries with conquest crumbs of knowledge with pretending to have a power over science. Nobody have power over knowledge and cannot immure a science. That is a reason for unconditional notion in science: 'Do, or do not. There is no 'try' ! Today's human is not developed on the basis of tries but realization, and in science that was always something clean and forward humanistic aims directed. Many such thinking you can recognize in this journal with hope that 'tomorrow' will be more incorporated in permanent human society values. In kinesiology or sport science it is especially important and represents continual line of moral that we will not abandon. Great Giordano Bruno says: 'The truth will not change because more of less people believes in it'. And as long as at least one man exists with such idea, science will exist as light and guideline of human race. That guideline we will continue to follow.

Executive Editor
Danijela Bonacin, MSc st.

Učini, ili ne učini. Ne postoji 'pokušaj' !
(Yoda – 'Imperija uzvraća udarac')

Dragi čitatelju,
'Prikazi' naših želja i djelovanja u znanosti uvijek se odražavaju na dva načina. Jedan je operativni s primjenom saznanja u realnom životu, a drugi je akumulacija ukupnih spoznaja za koju ne moramo biti sigurni kada, gdje i kako će se oživotvoriti. Pod izraženim nepotrebnim pritiskom što brže primjene znanja danas, gubi se iz vida da mnoga od tih znanja nisu dovoljno provjerena i da dugoročno mogu uzrokovati brojne poteškoće i probleme. To vrijedi za sva područja ljudskog djelovanja i za sve znanstvene discipline. Baš zato, moralnost naših djelovanja učinit će buduća vremena upravo onakvima kakvima ih mi danas vidimo, jer je budućnost zasijana danas, a neki njeni dijelovi čak mnogo ranije - u našoj povijesti. Na taj način gledano, kompletne spoznaje ljudskog roda nisu, a niti mogu biti ograničene na samo mali vremenski segment, tj. onaj u kojemu baš mi živimo. Stoga, a da bi bili potpuno čisti pred moralnim 'ja', moramo u znanosti ostati hrabri, čvrsti i ponosni. Ne smije se popustiti pred agresivnim, pozitivističkim i u suštini površnim 'postrojavanjima' kojima se tek mrvice znanja iznose na pladanj onima koji pretendiraju da imaju moć nad znanošću. Nad znanjem nitko nema moć i ne može ga utamničiti. Zato, dragi čitatelju, u znanosti bezuvjetno egzistira ova misao: 'Učini, ili ne učini. Ne postoji pokušaj !' Čovjeka do današnjih spoznaja nisu doveli pokušaji, već ono ostvareno, a u znanosti to je uvijek bilo ono čisto i humanističkim ciljevima usmjereno. Mnogo od toga ćete prepoznati u časopisu, s nadom da će i ono 'sutra' biti još više inkorporirano u trajne vrijednosti ljudske zajednice. U kineziologiji ili sportskoj znanosti to je posebno važno i predstavlja trajnu liniju morala koju nećemo napustiti. Veliki Giordano Bruno je kazao: 'Istina se ne mijenja zato što u nju vjeruje ili ne vjeruje većina ljudi,' I dok bude makar jednog jedinog čovjeka s tom mišlju, znanost će postojati kao svijetlo i vodilja ljudskog roda. Tu vodilju mi ćemo nastaviti slijediti.

Izvršna urednica
Danijela Bonacin, MSc st.

THE ASSESSMENT-PREDICTION CAPACITIES OF TEACHERS DURING PHYSICAL ACTIVITIES IN THE PRIMARY SCHOOL IN ITALY: ANALYSIS OF THE RELATIONSHIP BETWEEN EXPECTED ENERGY EXPENDITURE AND ACTUAL ENERGY EXPENDITURE DURING A LIGHT PHYSICAL ACTIVITY LASTING 15 MINUTES

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Preliminary scientific communication

Abstract

The present pilot study addresses the need of assessing the existence of significant elements which would justify a more deep following study on how the lack of specific skills training in the areas of physical education assessment and technology for the measurement of physiological parameters involved in the experience of teaching-learning through and about physical and sports activities, could negatively affect the didactics, realizing movement activities in which the intensity level does not correspond to the real intentions of the teacher. Specifically, the aim was to analyze the relationship between expected values of energy expenditure with the actual energy expenditure during a light physical activity lasting 15 minutes, using a portable calorimeter. The methodology of the research required the adoption modalities appropriate to the Italian school context that has some peculiarities that do not allow the use of certain procedures traditionally used in other fields of research on motor-sports activities (Sibilio, 2008). The sample was made of 176 primary school students of Campania Region (Italy), from 11 classes including 2 classes of year one, 2 of year two, 2 of year three, 3 of year four and 2 of year five. The results showed that the teaching methods used by teachers appear not suitable for a light physical activity. In fact, in six classes out of 11 it was reached or exceeded the minimum level corresponding to intense physical activity.

Key words: *physical and sports activities, teachers training, didactics, energy expenditure, calorimeter*

Introduction

Several studies conducted at the international level in recent years have highlighted the importance of teachers training in physical and sports activities for the development of healthy and effective motor habits in children in the period of primary schooling (Stewart et al., 2004; Fairclough et al., 2006, Bailey et al., 2009). In this respect, the so-called Berlin Declaration has drawn international attention on the need "to recognize that quality Physical Education depends on well-qualified educators and scheduled time within the curriculum" (Penny et al., 2009). Italy has responded to this need for qualification of teachers in the physical education field, emerged on the international level, with an increasing attention to the physical and sport practice, even if without reaching a final resolution of the problem of the professional primary school teachers training, which has to consider methodological and assessment knowledge that should be part of a qualified professional. The delineation of the training path of primary school teachers in Italy has in fact followed a long process that has begun to produce its effects only in 1998, when the Ministerial Decree 26/05/98 (G.U. 3/07/98) no. 153 with the establishment of the Degree course in Sciences of Primary Education, started the new university teachers formation targeted, for the first time, to the academic qualification of teachers of infant and primary school, building up at the same time, a decent and institutionally recognizable training dimension of physical education. In most university curricula for the teaching profession, also in the training of teachers of different orders and degrees of study, have been away didactics, teaching methodology, laboratory experiences and practical training that are crucial in the building of a portfolio of skills, that can be considered a synthesis of theory and teaching practice (Sibilio & Gomez-Paloma, 2004). The new model of university education, proposed by the Ministerial Decree of 1998, has placed new emphasis on the need for a greater specialization in the teaching of physical activities during infancy and preadolescence, including in the degree course physical and sports disciplines, exercises, practical training courses and training laboratory, which have, for the first time, represented a privileged and indispensable area for the qualification of the university curricula of will-be teachers. In parallel, there has been a growing need to start new experimentations aimed at defining the training needs of teachers who sometimes apply teaching methods in the field of physical and sports activities in an absolute unawareness of the physiological effects produced on students. At the same time, the focus on procedures and assessment tools to

promote quality physical education at international level (Shepard, 2000; Hay, 2006) imposes a necessary testing of instruments not traditionally used in school settings, that are, for their characteristics of handling and measurement accuracy (Jakičić, 2004; Arvidsson, 2007), valid aids in verifying the results of the adopted teaching methodologies. In this regard, the present pilot study addresses the need of assessing the existence of significant elements which would justify a more deep following study on how the lack of specific skills training in the areas of physical education assessment and technology for the measurement of physiological parameters involved in the experience of teaching-learning *through and about* physical and sports activities, could negatively affect the didactics, realizing movement activities in which the intensity level does not correspond to the real intentions of the teacher.

Methods

The research required the adoption of instruments and methodologies appropriate to the Italian school context that has some peculiarities that do not allow the use of certain procedures traditionally used in other fields of research on motor-sports activities (Sibilio, 2008).
The methodology included the following steps:

- setting of a university-school working group made of researchers of the University of Salerno and teachers of primary school (school that in Italy is attended by 6-11 aged students);
- an integrated school-university plan to share the aims of the research, the methods and the procedures;
- arrangement of an informative report to collect data on age, weight, height, diets, or any sports done as well as information about students' lifestyles;
- training to teachers how to use the portable multi sensor monitoring system (calorimeter).
- request to the students to perform a physical activity of warm-up lasting 15 minutes;
- application of the required physical activity, collecting data of the caloric consumption of each student;
- Analysis and processing of data related to the calorimetric recordings made with the production of a vertical bar graph of the average total energy expenditure and of the average expenditure for the physical activity performed.

Sample
The research was carried out using as a sample students attending the primary school of Campania Region (Italy) formally agreed with the Department of Educational Sciences of the University of Salerno for a total of 176 students from 11 classes 2 classes of year one, 2 of year two, 2 of year three, 3 of year four and 2 of year five.

Instruments
As a calorimetric monitoring system was used the portable metabolic holter *BodyMedia* enables the recording and analysis of accurate data on energy expenditure, physical activity and lifestyle. The system is made of a clinically validated portable calorimeter, the *SenseWear Armband*, and software for viewing and analyzing data. The Armband continuously records a series of physiological data of the body. The collected data are then analyzed, graphically displayed and presented by the software on a report that clearly shows the energy expenditure of the subject.

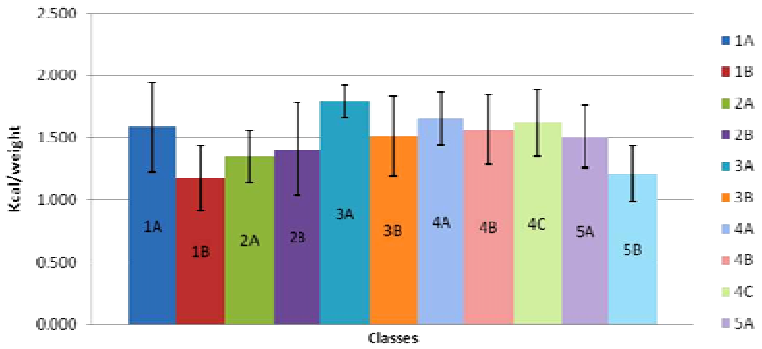
Units of measurement
The units of measurement used for the detection of calorie consumption are kcal and METs, and in particular it was chosen to place greater emphasis on the use of METs as standard unit of measurement widely used for the evaluation of calorie expenditure. MET (Metabolic Equivalent of Tasks) is the unit of measurement used to describe the intensity of physical effort and is based on multiples of oxygen consumption at rest - MET = kcal / kg / h.

Results

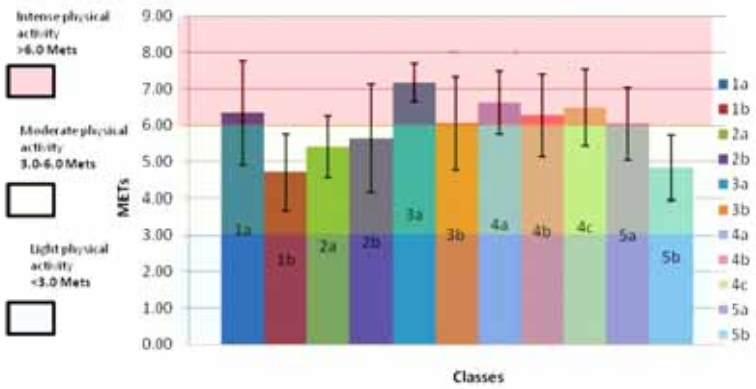
Graphs 1 and 2 shows the average values of energy consumption respectively in kcal / kg and METs for each examined class, while Table 1 and 2 show respectively the values in METs of standard consumption for various physical activities and the processed data collected by the observations. Table 1 and in Graph 2 show energy expenditure above the expected average consumption in METs for a light physical activity such as warm-up. Graph 3 shows the comparison between the total average of expended METs and expected METs. Graph 3 shows a clear difference in consumption between the standard for a light physical activity such as warm-up and the average expenditure values actually detected. In particular, in 97% of the observations the expenditure of METs appears to be greater than that required by a light physical activity that is 3 METs, whereas in 52% of the observations the value of METs consumed exceeds the standard in METs required for a moderate physical activity, reaching average values of expected consumption in intense physical activity.

Table 1. Intensity and METs

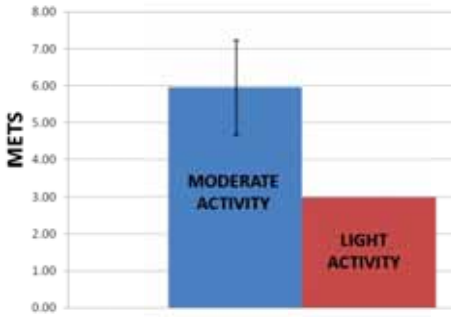
Intensity	METs
Light physical activity	< 3.0
Moderate physical activity	3.0-6.0
Intense physical activity	> 6.0



Graph 1. Average caloric expenditure



Graph 2. MET's average expenditure



Graph 3. Differences in consumption

Table 1. Data for 11 classes (1a - 5b)

	weight	Kcal	Kcal/ weight	st.dv. Kcal/ weight	Max	Min	Range	st. dv. Kcal	cff Var %	METs average	st. Dev. METs
1a	24,6	38,73	1,586	0,359	57	16	41	11,50	29,69	6,34	1,43
1b	29,7	35,29	1,177	0,258	67	16	51	12,04	34,13	4,71	1,03
2a	30,0	40	1,352	0,212	50	32	18	4,73	11,85	5,41	0,85
2b	39,28	39,28	1,409	0,370	54	23	31	7,19	18,31	5,64	1,48
3a	34,8	62,5	1,791	0,132	99	37	62	14,62	23,41	7,17	0,53
3b	34,4	52,47	1,514	0,321	92	19	73	15,94	30,40	6,06	1,28
4a	45,2	75,64	1,653	0,217	107	42	65	22,70	30,01	6,61	0,87
4b	37,5	58,42	1,568	0,282	77	25	52	12,65	21,67	6,27	1,13
4c	39,3	63,33	1,621	0,266	88	43	45	12,93	20,43	6,48	1,06
5a	64,36	64,36	1,510	0,250	115	24	91	22,42	34,83	6,04	1,00
5b	41,0	49,23	1,21	0,22	76	29	47	13,95	28,34	4,84	0,89
Tot	weight	Kcal	Kcal/ weight	st.dv. Kcal/ weight	Max	Min	Range	st. dv. Kcal	cff Var %	METs average	st. Dev. METs
	35,14	52,41	1,488	0,32	115	16	99	19,08	21,50	5,95	1,28

Conclusion

The data collected showed that the teaching methods used by teachers appear not homogeneous and not suitable for a light physical activity. In fact, in six classes out of 11 it was reached or exceeded the minimum level corresponding to intense physical activity. This highlights the lack of knowledge by teachers of the effects produced by the used teaching methods and the proposed activities, providing the possibility of a further deepening of the analysis of training needs of teachers that nowadays, despite the attention given to their training at academic level, is still very weak in terms of methodology and assessment skills and not very interested in the physiological outcomes that contribute to the effectiveness of physical education teaching.

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PROCJENA PREDIKCIJE KAPACITETA UČITELJA ZA VRIJEME TJELESNIH AKTIVNOSTI U OSNOVNOJ ŠKOLI ITALIJE: ANALIZA ODNOSA OČEKIVANE I STVARNO UTROŠENE ENERGIJE LAGANIH TJELESNIH AKTIVNOSTI POSLIJEDNJIH 15 MINUTA

Sažetak

Predstavljeno pilot istraživanje adresira potrebu ocjene postojanja značajnih elemenata koji će opravdati mnogo dublje istraživanje koje slijedi. To istraživanje će biti sprovedeno u vezi načina na koji nedostatak trenažnih vještina u prostoru tjelesnog odgoja, ocjene sposobnosti i tehnologije mjerenja fizioloških parametara uključenih u trenažno-učeća iskustva u i kroz tjelsni odgoj i sport, može negativno utjecati na nastavnu realizaciju kretnih aktivnosti pri čemu razina intenziteta ne korespondira sa stvarnim namjerama učitelja. Posebno, cilj je bio analizirati relacije između očekivanih vrijednosti potrošnje energije s aktualnom potrošnjom energije za vrijeme lagane tjelesne aktivnosti u zadnjih 15 minuta, uz korištenje kalorimetra. Metodologija istraživanja zahtijevala je usvajanje odgovarajućih modaliteta u kontekstu talijanskih škola što ima određene posebnosti koje ne omogućavaju korištenje dosta postupaka tradicionalno korištenih u drugim područjima istraživanja sportsko-motoričkih aktivnosti (Sibilio, 2008). Uzorak je činilo 176 učenika osnovne škole u Regiji Campania (Italija), iz 11 razreda uključivo po 2 razreda od prve do pete godine škole (osim u četvrtoj godini – 3 razreda). Rezultati su pokazali da nastavne metode koje su učitelji koristili nisu prikladne za laganu tjelesnu aktivnost. U suštini, u 6 od 11 razreda dosegnuta je ili premašena minimalna razina korespodentna intenzivnoj tjelesnoj aktivnosti.

Ključne riječi: *tjelesne i sportske aktivnosti, priprema učitelja, didaktika, potrošnja energije, kalorimetar*

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METHODICAL ASPECTS OF MAXIMUM SPEED DEVELOPMENT

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Review paper

Abstract

The maximum speed, which people produce in movement, depends on various factors. Maximum speed is a product of the frequency and the length of stride. Development of maximal speed is not constant, but has certain oscillations, particularly in the adolescence period. In methodology of training for development of maximal speed there are two paths available: synthetic and analytic. In synthetic training the emphasis is on the development of speed as a whole, whereas in analytic training the emphasis is on separate training of individual speed components. Finally, main strategy of efficient speed training is based on the use of such training methods and tools, which prevent stabilisation of speed. Development of maximal speed is a long term process with many scientific comprehensions included.

Key words*: speed, maximum, development*

Introduction

The maximum speed, which people produce in movement, depends on various factors. These factors are related to morphological and physiological characteristics, energetic mechanisms, age, gender, bio-motor abilities, inter- and intra-muscular coordination and optimal biomechanical technique of movement. Locomotive speed in a form of sprinting run is one of the most important abilities, which defines the successfulness of sportsmen in many sports situations. From the genetic (hereditary) motor programme aspect, speed can be classified into primary phylogenetic human movements. In specific sports situations, speed is being manifested in a form of a »three-segment model«. The model consists of speed, strength and coordination. Pondering of individual segments of this model depends on the particularities of specific sports discipline. Maximum speed is a product of the frequency and the length of stride. Both parameters are mutually dependant; they are also linked to the processes of central regulation of movement, to the morphological characteristics, bio-motor abilities and energetic processes. The relationship between the frequency and the length of a stride is individually defined and automated (Hay, 1993; Delecluse et. al., 1995; Donatti, 1996. Kyrolainen et. al.,2001)Changing one parameter results in the changes of a second parameter as well. When a length of a stride is increased, the frequency decreases and vice versa. With increased speed both parameters increase (see Figure 1).

Frequency of stride depends on:

- Functioning of central-neural system
- Inter- and intra-muscular coordination
- Central and peripheral neural fatigue

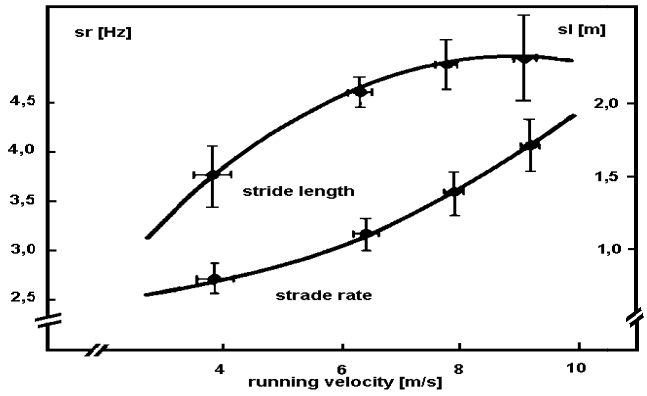

Figure 1: Relationship between speed, frequency and length of stride

The length of stride depends on (see Figure 2):

- Morphological characteristics (the length of lower extremities)
- The reactive force of surface (an impulse at take-off)
- Duration (time) of contact phase
- Dynamic flexibility in hips
- Take-off distance
- Touchdown distance

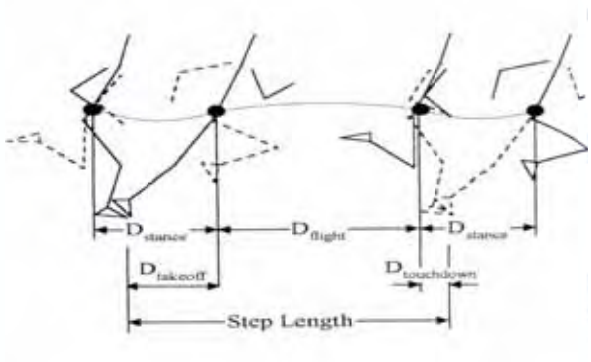

Figure 2: Kinematic structure of sprinting stride

Methodology of speed development

In methodology of training for development of maximal speed there are two paths available: synthetic and analytic. In synthetic training the emphasis is on the development of speed as a whole, whereas in analytic training the emphasis is on separate training of individual speed components. In both paths the basic requirements are that movement is being executed in maximal speed, with optimal rational technique where fatigue does not prevent realisation of maximal speed of movement. One of the basic training methods for development of speed is method of repetition. Basic tendency is in aiming to overcome own maximal speed (Zatsiorsky, 1975). Speed has to be maximal or sub-maximal, as only such training pushes the limit of speed in desired direction. Rest period is determined by two processes: central fatigue – excitation of neural system and physiological – biochemical parameters. Following fast movements, the excitation of neural system drastically increases and rapidly decreases after the loading. Considering this factor, the rest period could be relatively short. However, the length of rest period also depends on anaerobic functions. Rest period in speed development training needs to be sufficiently short that the level of excitation does not reduces to minimum and sufficiently long that the functional parameters return to their initial or near initial values.

Running is elementary inborn movement with already built programme in the central neural system. Efficiency of running from the speed point of view is relatively individual category, which depends on the variety of hereditary functions. In the development of children, a term "natural – biological development of sprinters speed" is being used (see Figure 3). This development depends on body height, body weight, development of biomotor abilities and the formation of motor stereotypes of movement.

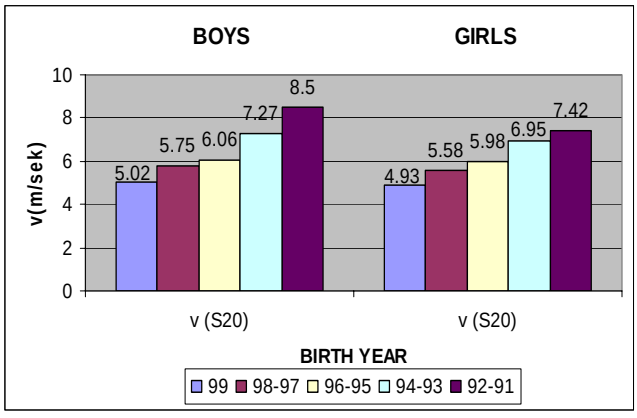

Figure 3: Biological development of maximal speed of boys and girls in primary school (Bračič, Tomažin, Čoh, 2009)

Development of maximal speed is not constant, but has certain oscillations, particularly in the adolescence period, when morphological and biomotor characteristics of young people change.

Due to acceleration of longitudinal parameters, frequency and length of stride change (see Figures 4 and 5). The length of stride increases and the frequency of stride decreases significantly. Frequency does not change only as a result of morphological changes, but also due to disruption of proprio-receptive mechanisms for movement control.

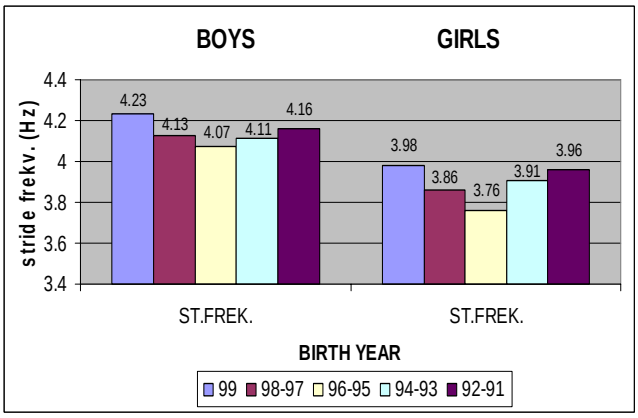

Figure 4: Development of frequency of stride in boys and girls in primary school (Bračič, Tomažin, Čoh, 2009)

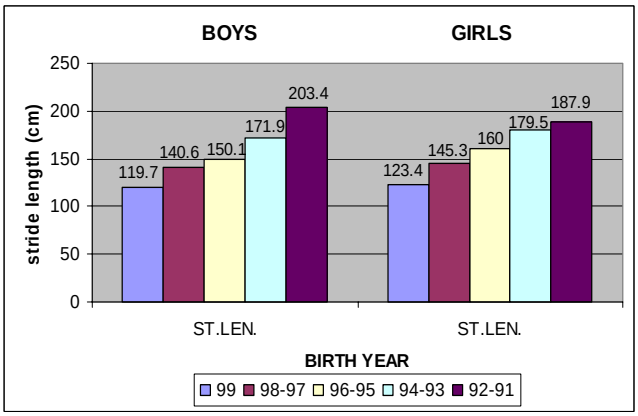

Figure 5: Development of stride length in boys and girls in primary school (Bračič, Tomažin, Čoh, 2009)

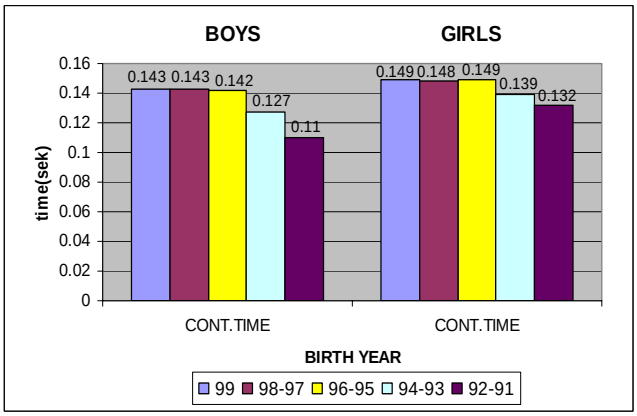

Figure 6: Duration of contact phases of sprinters stride for boys and girls in primary school (Bračič, Tomažin, Čoh, 2009)

The biggest differences in the development of maximal speed of pupils of both genders occur between the ages of 12 and 14, mainly in boys due to development of strength. The duration of contact of sprinters stride in boys is rapidly reducing after the age of 12 (see Figure 6). Duration of contact phase is one of the main criteria in selecting young sprinters (Mero, Luhtanen and Komi, 1986; Mero, Komi and Gregor, 1992, Zatsiorsky, Kraemer 2009). Synthetic principle of speed development suggests large amount of spontaneous training of young people in different sports, where the ability is manifested also with other biomotor characteristics. Development of speed has to be related to complex motor situations with a strong informational movement component. Namely, this is a period of so-called "sensitive phase" in the development of children (9-13 years), which is very suitable for development of speed potential. Central neural system is being developed, particularly emphasised is formation of myelin nerve sheath, which serves as a transporter of neural impulses from central neural system to active muscles. In this period, particularly the speed of transfer of such impulses, which generate the speed of movement, can be influenced.

Analytical approach is related to training of individual technical elements of sprinting run, which are similar in structure to locomotion in sprint. They include ABC exercise of sprinting: skipping, jumping, running with accentuated take-off, jogging etc. These exercises might seem abstract to children, however, their role in creation of correct technical running model and prevention of technical errors is very important. Running is a natural genetic need of children. Maximal locomotive speed is an ability, which in young people has to be trained in small volume due to two reasons:

1. Young people have yet not developed mechanisms of movement control under the maximal loading. Consequences are unnatural movement, jerking movements and movement with number of errors.
2. There is a possibility for "speed barrier" occurring, which could result in stagnation in development or even in deterioration of the ability. Generally speaking, inadequate training (narrow specialisation) can lead to formation of certain stereotype in central regulation of movement, which would prevent development of speed. Speed is being based on a specific motor programme. The sooner maximal speed is being developed, more programmes become stabilised and lead to prevention of progress in this biomotor ability.

Stabilisation of speed – speed barrier

Numerous repetitions, which are necessary for creation of automated and rational movement, lead to creation of motor stereotype and consequently to stabilisation of movement. Together with stabilisation some kinematic – dynamic parameters are being set; they are manifested with the length and frequency of stride.

So-called "speed barrier" occurs, which was first explained by Soviet researcher N.G. Ozolin in 1970. The main contradiction in the development of maximal speed is following: in order to increase speed, numerous repetitions of specific move are required; on the other hand larger number of repetitions leads to strong dynamic-kinematic stereotype and strong speed barrier. In addition, the increase of training volume does not have positive effects, but even more stabilises the achieved speed of movement. Stabilisation of movement is the main inhibitor of development of speed potential.

Main strategy of efficient speed training is based on the use of such training methods and tools, which prevent stabilisation of speed. Creation of speed barrier follows certain chronology (Zatsiorski 1975):

1. phase of prevention of speed barrier
2. phase of destruction of speed barrier
3. phase of suppression of speed barrier

Tools and methods for preventing the speed barrier :

- spontaneous exercising in children
- late specialisation
- development of basic motor abilities – elementary motor movements
- overall preparation – »multi - lateral training«
- development of »motor software« - motor knowledge and skills
- development of elementary movement technique
- ABC training of running
- speed training with non-specific tools and methods (elementary and sports games, relays)

Tools for breaking of speed barrier

- non-specific running
- running down an incline
- running up an incline
- running with resistance
- running with pulling a weight
- running in low depth water
- running with and against the wind
- running in the sand
- running with a parachute
- running with »sprint machine«
- contrast sprinting runs
- multi-throwing training

Tools for surprising the speed barrier

1. Stopping the specific training
2. Substitution of speed training with the training of strength, coordination and precision
3. Technical running training
4. Coordination of running in a sub-maximal regime
5. Compensational training

Conclusion

Speed is a complex and subtle biomotor ability, which in real sports situations occurs in various forms. One of the most important segments of speed potential of sportsmen is maximal speed. From the biomechanical point of view, maximal speed is structured with the length and frequency of stride.

The goal of training process is improvement of these two segments, which are relatively highly genetically pondered and depend on several neuro-muscular factors. Development of maximal speed is a long term process, which is related to optimal control of agonist and antagonist muscles of sprinting movement pattern.

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METODIČKI ASPEKTI RAZVOJA MAKSIMALNE BRZINE

Sažetak

Maksimalna brzina, koju ljudi produciraju u kretanju, ovisi o više faktora. Maksimalna brzina je product frekvencije i duljine koraka. Razvoj maksimalne brzine nije konstanta, već pokazuje određene oscijalcije, posebno u razdoblju adolescencije. U metodologiji treninga za razvoj maksimalne brzine postoje dva moguća pristupa: sintetički i analitički. U sintetičkom treningu naglasak je na razvoju brzine u cjelini, dok je u analitičkom treningu naglasak na odvojene treninge pojedinačnih komponenti brzine. Konačno, glavna strategija efikasnog treninga brzine temelji se na korištenju trenažnih modela kao alata, čime se prevenira stabilizacija brzine. Razvoj maksimalne brzine je dugoročni process s mnogo uključenih znanstvenih spoznaja.

***Ključne riječi**: brzina, maksimum, razvoj*

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WITHIN-SEASON VARIATION IN THE BODY COMPOSITION OF ASIAN YOUTH PROFESSIONAL SOCCER PLAYERS

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Original scientific paper

Abstract

Body composition is an important aspect of soccer fitness. There is a dearth of longitudinal data on the intra-seasonal variation in the body composition parameters of youth professional soccer players especially of Asian origin. This study assessed the body composition profile of the Asian youth professional soccer players (n=20; Mean ± SD, age 17.5 ± 0.3 years, stature 1.73 ± 0.04 m, body mass 67.2 ± 7.5 kg) through the entire season. Body mass, percentage body fat (% BF), lean body mass (LBM) and bone mineral density (BMD) of outfield youth professional soccer players was determined using dual-energy x-ray absorptiometry (DXA) during the pre-season, early in-season and end mid-season respectively. Results showed that the Asian youth professional soccer players had similar anthropometric characteristics compared to Asian adult elite players but were shorter and lighter than European youth players. There was a significant decrease ($p < 0.05$) in the % BF and a significant increase ($p < 0.05$) in LBM during the pre-season period. However, negative adaptations during the competition phase indicated that training and competition load was insufficient to improve or maintain the adaptations in the % BF and LBM. The whole body BMD significantly increased through the soccer season. Area-specific BMD of the pelvis and the lower limbs showed positive osteogenic adaptations during the soccer season. Our results showed that the body composition parameters of Asian youth professional soccer players change through the soccer season. Such data can expand the bases of comparison between different soccer playing populations and add to the prospects of research on soccer performance. Further studies on the effect of body composition parameters on different aspects of soccer performance are desirable.

Key words: *youth professional soccer players, Asian, body composition, soccer season*

Introduction

Research in soccer physiology and medicine has seen notable development in recent years. Investigations on the ideal physiological and anthropometric characteristics of successful soccer players (Bangsbo and Mizuno 1988; Shephard 1999) have shown that there has been a notable increase in the overall intensity of the game which can be attributed to the increase in the speed and agility of the players. In this context, body composition constitutes an important aspect of fitness in soccer as the game involves repeated high-intensity running and repeated lifting of the body mass against gravity for running and jumping. Recent studies have suggested body composition to be an important supplementary fitness component determining competitive preparedness in professional soccer (Sutton, Scott, Wallace et al., 2009). Furthermore, body composition has also been suggested to be a predictor of success in soccer (Arnasson, Sigurdsson, Gudmundsson 2004). However, the majority of research on soccer has focused on the physiological aspect of the game. Body composition and its implication on soccer performance has received surprisingly minimum attention. Moreover, it has been said that the body size within normal range is of minor importance for physical performance in soccer and therefore, values of body mass and height, % BF and other anthropometric measures are of less interest in soccer (Ekblom 1986).

Currently there is insufficient information regarding body composition in soccer players through an entire soccer season (Morgan, Weston, Nevill 2005). Previous investigations on the body composition of soccer players have used methods like skinfold thickness measurements. Technologically advanced methods like the dual-energy x-ray absorptiometry (DXA) has been scarcely used in soccer research. Moreover, the available data on body composition of soccer players is largely limited to % body fat. There is a relative scarcity of data on the lean body mass (LBM) and bone mineral density (BMD) in soccer players (Fredericson et al. 2007). BMD can be reasonably suggested to be of significance in soccer as the game involves high-impact activities like speed running and jumping that cause high mechanical loading and strains on the skeleton (Robling, Hinant, Burr, Turner 2002; Skerry 1997). While the literature on the physical and physiological attributes of American and European soccer players is extensive (Casajus 2001; Davis, Brewer, Atkins 1992; Rhodes et al. 1996; Mangine et al., 1990; Ostojic 2003), data on the Asian youth professional soccer population is scarce. In sports involving long competition season, maintaining an optimal physical fitness is a difficult challenge and few studies have dealt with changes in the physical and performance characteristics of soccer players through the season (Davis, Brewer, Atkins 1992).

A recent study has provided an account of the relationship between anthropometric and physiological characteristics in youth soccer players (Wong, Chamari, Dellal et al., 2009). However, the study is limited in its domain by being cross-sectional and providing information limited to the body mass, stature and the body mass index. Longitudinal data on the detailed anthropometric profile of youth professional soccer players of Asian origin is yet to be reported. Such data can further expand the bases of comparison between different soccer playing populations and also add to the prospects of future research on soccer performance. Consequently, the purpose of this study was to determine and evaluate the changes in the body composition profile of Asian youth professional soccer players through a complete season and to provide a comparative account of the results with the existing data from different soccer populations.

Methods

Participants

The present study was conducted on male youth professional soccer players, excluding goalkeepers. Thirty five outfield players volunteered to participate in the study. However, owing to injuries, drop outs and the Coach's decision on selection leading to player turnover, twenty players eventually fulfilled all the requirements of the study. The physical characteristics of the participants at the time of initial recruitment were (Mean ± SD) age 17.5 ± 0.3 years, stature 1.73 ± 0.04 m and body mass 67.2 ± 7.5 kg respectively. The participants in the study were the members of the Singapore National Football Academy's under-18 team, the best soccer talent in the country in that age group. The team represented the National youth soccer team and also participated in a local professional soccer league. With respect to the training, briefly, the participants underwent systematic soccer training for 90-120 min once a day five days a week during both the pre-season and the in-season periods. In addition, there were specific fitness training and strength training sessions during the pre-season. However, the in-season period predominantly comprised of technical and tactical training. The participants played at least one friendly match every week during the pre-season period while they played at least one match in the league every week during the competition season.

Instrumentation and Protocol

The soccer season spanned ten months and was broadly divided into the pre-season and the in-season phases. The in-season season phase was further sub-divided into early in-season, mid-season and the end-season phases respectively. The participants underwent a dual-energy x-ray absorptiometry (DXA) scan for body composition assessment. All the scans were performed by a trained radiation worker and the effective radiation dose was approximately 0.02 mrem per person. The whole body DXA unit (Hologic QDR Series, Discovery W, Hologic Inc., MA, USA) was used. The DXA machine was calibrated every morning during the test days using a standard, which is a block of tissue with four bone-simulating chambers of known bone mineral content (DPA/QDR-1, Anthropometric Spine Phantom). All data were generated from the Hologic computer software (Version 9.8). Pilot studies on trained intermittent games athletes in our laboratory had found the DXA equipment of high reliability (Table 1).

The scans were conducted thrice, during the start of the pre-season, early in-season and during the end mid-season respectively. There was a period of 12 weeks between the first and the second scan and 13 weeks from second to the third scan respectively. As the majority of the end-season period coincided with the fasting month of Ramadan, data collection was not performed during this phase. All the scans were conducted during the same time period of the day (between 9-11 AM). The Head Coach was advised to conduct low-intensity training of a general nature the evening prior to the scans and a gap of at least three days were ensured between match play and the scans.

Necessary ethical approval was obtained from the Institutional Human Research Ethics Committee. As the participants were below the legal age of consent, parental consent was also sought prior to the commencement of the study. Repeated Measures Analysis of Variance (RM ANOVA) was used to analyse the data. A Bonferroni post hoc analysis was performed in the event of a significant effect. The level of significance was accepted at $p<0.05$. SPSS version 14.0 was used for data analysis.

Results

Table 1. Reliability statistics for body composition parameters using DXA scan (95% confidence limits are presented for ICC and CV; n=14)

Measure	ICC	Bounds		CV	Bounds %		Change in mean%	rLOA x/÷	
BSA	0.98	0.84	0.99	0.80	0.50	1.90	0.20	1.00	1.02
BMD	0.97	0.79	0.99	1.20	0.70	2.90	0.30	1.00	1.02
BF	0.99	0.97	1.00	2.70	1.70	6.80	1.30	1.03	1.08
LBM	0.99	0.97	1.00	0.20	0.10	0.50	0.20	0.99	1.00
TBM	0.99	0.97	1.00	0.10	0.10	0.30	0.10	0.99	1.01

Note: ICC-intraclass correlation; CV-coefficient of variation; rLOA-ratio limits of agreement; BSA- body surface area; BMD-bone mineral density; BF-body fat; LBM-lean body mass; TBM-total body mass

Table 2. Anthropometric characteristics of the Asian youth professional soccer players (mean±SD)

Phase (m) / Season	Stature	Mass	% BF	% LBM	BMD
Pre	1.73 ± 0.04	67.2 ± 7.5	13.2 ± 2.8	82.5 ± 2.7	1.20 ± 0.06
Early	1.74 ± 0.04	66.2 ± 7.3	11.2 ± 2.2	84.5 ± 2.3	1.22 ± 0.06
End mid	1.74 ± 0.04	68.0 ± 7.9	12.4 ± 2.9	83.3 ± 2.8	1.23 ± 0.06

Note: m-metre; kg- kilogram; BF- body fat; LBM-lean body mass; BMD- bone mineral density

Table 3. Lean body mass profile of the Asian youth professional soccer players (mean±SD)

Phase (m) / Season	LBM (% of BM)	LBM ARM (% of BM)	LBM TR (% of BM)	LBM LEG (% of BM)
Pre	82.5 ± 2.7	8.5 ± 0.4	37.2 ± 1.4	31.0 ± 1.6
Early	84.5 ± 2.3	8.7 ± 0.4	37.9 ± 1.0	32.2 ± 1.3
End mid	83.3 ± 2.8	8.8 ± 0.4	37.7 ± 1.3	31.1 ± 1.4

Note: LBM- lean body mass; BM- body mass; SD- standard deviation

Table 4. BMD profile of the Asian youth professional soccer players (mean±SD)

Phase (m) / Season	BMD (g*cm-2)	BMD L-SPINE (g*cm-2)	BMD PELVIS (g*cm-2)	BMD LL (g*cm-2)
Pre	1.20 ± 0.06	1.22 ± 0.14	1.35 ± 0.11	1.39 ± 0.07
Early	1.22 ± 0.06	1.25 ± 0.14	1.35 ± 0.10	1.41 ± 0.07
End mid	1.23 ± 0.06	1.23 ± 0.13	1.39 ± 0.11	1.41 ± 0.09

Note: BMD-bone mineral density; L-spine- Lumbar spine; LL- lower limbs (average of right and left leg)

Table 5. Anthropometric characteristics of the Youth and the elite Asian adult soccer players (mean±SD)

Study	Country (m)	Phase of (kg)	Stature	Body mass	% IBF
Wong & Wong (under 17)	Hong Kong	NR	1.73 ± 0.52	64.2 ± 8.1	NR
Aziz et al. (2006)	Singa pore	Pre	1.74 ± 0.08	69.7± 10.1	10.6 ± 2.3
Adhikari & Kumar, Das (1993)	India	NR	1.69 ± 0.02	60.1 ± 2.3	NR
Al-Hazaa et al (2001)	Saudi	Early	1.77 ± 5.90	73.1 ± 6.8	12.3 ± 2.7
Chin et al. (1992)	Hong Kong	Pre	1.73 ± 0.04	67.7 ± 5.0	12.3 ± 2.7

Note. m- metre; kg-kilogram; % BF- percentage body fat; Method of % BF estimation – present study: DXA, previous studies: skinfold method; NR- not reported

Table 6. Pre-season % BF in elite soccer players (mean ±SD)

Study	Country	Age (yr)	% BF
Aziz et al. (2006)	Singa pore	17.5 ± 0.3	10.6 ± 2.3
Morgan et al. (2005)	EFL	25.7 ± 3.9	10.5 ± 2.8
Arnason et al. (2004)	Iceland	22 ± 4.2	9.9 ± 0.5
Ostojić (2003)	Serbia	24.2 ± 0.2	11.5 ± 2.1
Casajus (2001)	Spain	23.5 ± 3.1	8.6 ± 0.91
Davis et al. (1992)	England	25.8 ± 3.1	10.5 ± 1.8

Note. EFL – English Football League

Table 7. Anthropometric characteristics of the participants and elite youth soccer players (mean)

Study	Country	Phase	Age	Mass	% BF
Murray et al. (2005)	Scotland	NM	16.6	67.5	12.2
Chimari et al. (2005)	Norway	Second Half	14.0	60.5	11.6
Vanderford et al. (2004)	North America	Camp	15.7	68.6	9.0
Majumdar (1998, UP)	India	Pre tournam.	18.1	66	10.0
Chin et Al. (1994)	Hong Kong	Pre tournam.	17.3	62.8	5.2

Note. % BF- percentage body fat; NM – not mentioned; Method of % BF estimation – present study: DXA, previous studies: skinfold method; data on Indian U 19 soccer team, P Majumdar, Scientific Officer, Sports Authority of India (UP = unpublished, personal communication, 07 May, 2003)

Table 8. Data for comparison of BMD in soccer players (mean)

Study	Age (yr)	Phase	BMD Whole (g*cm2)	BMD L-spine (g*cm2)	BMD Pelvis (g*cm2)	BMD LL (g*cm2)
Division 1 Fredericson et al.(2007)	21.0	NM	1.23	1.17	1.23	1.48*
Amateur Calbet et al (2001)	22.3	In-season	NM	1.19	1.45	1.53**
Young boys Nebigh et Al. (2009)	13.4	NM	1.10	0.90	1.14	1.28
Divis1- Prof. Wittich et Al. (1998)	22.6	Pre-season	1.41	NM	1.55	1.62

BMD-bone mineral density; L-spine- Lumbar spine; LL-lower limbs (average of right and left leg);
NM- not mentioned; *- BMD of Tibia; **- data averaged for right and left leg

Discussion

Each sport is characterised by its unique physical demands in different age-groups which is of importance to assess the elite performers to understand the demands of the sports at different stages of development. This is apparently the first study to describe the detailed profile of the anthropometric characteristics of the youth professional soccer players of Asian origin across a complete soccer season. The anthropometric characteristics of the youth professional soccer players (n=20) during the different phases of the soccer season is presented in Table 2. Pairwise post hoc analysis using Bonferroni correction showed that there was a significant decrease in the % BF and a significant increase in the LBM from pre-season to early in-season. However, results showed a significant increase in % BF and a significant decrease in LBM from early in-season to end mid-season. The LBM profile of the players during different phases of the season is presented in Table 3. There was no significant change in the body mass during the pre-season period. However, the body mass significantly increased from the early in-season to the end mid-season phase. Results also showed a significant time effect on the whole body BMD ($F(1.84, 35.09) = 28.67$, $p < 0.05$). Post hoc analysis showed a significant increase in the whole body BMD from the pre-season phase to the end mid-season phase. The BMD profile of the youth professional soccer players in different phases of the season is presented in Table 4. Results showed a significant time effect for % BF ($F(1.88, 35.83) = 19.02$, $p < 0.05$) and LBM ($F(1.88, 35.77) = 29.85$, $p < 0.05$). The results showed that the anthropometric characteristics of the Asian elite youth soccer players were comparable to the values found in Asian male adult elite players (Table 5).

The pre-season % BF of the youth players in the present study was higher than that reported in previous studies (Table 6). The participants in the present study however, were lighter and shorter than elite European youth soccer players in whom a stature above 1.8 m and body mass in 80 kg range has been reported (Chamari et al. 2005; Helgerud et al. 2001; McMillan et al. 2005). Although the participants in the present study were younger than in the cited studies, age *per se* may not be the factor for a higher BF as lower % BF (Table 7) have been reported by previous studies on youth elite soccer players. A possible explanation for a higher pre-season % BF of the players in our study may be based on the transition of the participants from under-17 age group team to the under-18 age group team. While the Singapore National U18 team has frequent international championship and tournament commitments and also participates in a season long local professional league, the U17 team plays in only one regional international tournament organised locally during the mid-year. The opportunities for additional competitive games are scarce and infrequent. The training and match play load gets further minimised towards the later third of the calendar year. All of that owing to the academic commitments of the players (personal communication, Director, National Football Academy, Singapore, April 3, 2007). This suggests that the training and competition load would have been low especially during the later part of the year. Furthermore, the players did not have a structured off-season training programme before joining the National U18 team. Given the understanding that the % BF is affected by the training and competition loads through the season and there are also nutritional and behavioural changes with respect to training during the off-season period (Ostojic 2003), a relatively higher % BF of the soccer players at the start of the subsequent pre-season was therefore not surprising. The significant increase in the % BF from the pre-season to early in-season in the players in our study further substantiates previous findings that the maximum BF loss in soccer players is during the pre-season conditioning (Morgan, Weston, Nevill 2005; Casajus 2001; Ostojic 2003).

The predominant reason for this loss of BF would have been an increase in both the training volume and intensity during the pre-season period. This included both game and fitness-related training. However, contrary to the cited studies, a significant increase in the % BF from the early in-season period to the end mid-season period might have been an outcome of the reduced training load during the in-season period. During the competition in-season, the players were required to play 24 games in the seven month (28 week) period (April-October) amounting to playing on an average one game a week. While the training scheme during the pre-season period included general and specific fitness training including strength training, majority of the training during the competition season was related to individual tactical training, ball possession drills, set pieces and team tactical work. Our studies on monitoring exercise intensity during training have found that the work-intensity was significantly low during training involving tactical and technical work, set-piece and ball possession drills compared to training that involved high-intensity soccer-specific exercise like modified games (mean HR 122 b·min-1 vs 156 b·min-1, $p < 0.05$). Similar findings have also been reported in previous studies (Eniseler 2005). Moreover, there was minimal inclusion of high-intensity fitness training and strength training during the in-season period. This was suggestive that the match play in itself is insufficient as a stimulus for maintaining or decreasing the % BF and in this respect, and soccer players are likely to benefit from fitness-related training during the competition season. A limitation of the literature on both within and between season changes in the body composition of soccer players is the focus on body fat. There is a relative scarcity of the data on the lean body mass (LBM) and bone mineral density (BMD) of professional soccer players. The present study used DXA as the method for assessment of the body composition. This allowed the present study to provide data on LBM and BMD in addition to the % BF.

Lean body mass

Soccer players are characterised by a mesomorphic physique (Reilly 1996). As soccer involves strength requiring activities like acceleration and deceleration, jumps, tackles, sudden turns and all-out sprints, development of the LBM is essential to support such activities. In contrast, a higher % BF increases energy expenditure and reduces a player's power-to-weight ratio and decreases acceleration (Duthie, Pyne, Hooper 2003). Therefore, in soccer where the body is constantly lifted against gravity for activities like high speed running and jumping, a higher LBM is a desirable performance attribute.

Moreover, changes in the LBM through the season would also be useful in monitoring the athletes and assessing the effectiveness of training. The LBM of the youth players in the present study significantly increased during the pre-season and decreased from the early in-season to the end mid-season period. The decrease in the % BF and increase in the LBM during the pre-season period reflected the positive adaptations in the body composition to training and conditioning during this period. This can be attributed to a high training volume and intensity as well as fitness training including strength training during the pre-season period.

There was a significant increase in the LBM in the trunk and the legs of the players during the pre-season conditioning. However, while the increase in the trunk LBM was 1.8 %, there was a 3.8 % increase in the LBM in the legs thus corroborating the evidence (Katsuta, Kuno, Itai 1993) that the leg muscularity is an important determinant of mesomorphy in soccer players. On commencement of the competition season, multiple factors like the amount of playing time, training volume and intensity, dietary practices, illnesses, injuries and travelling affects the body composition (Duthie et al. 2006). An increase in the % BF and a decrease in the LBM with a significant increase in the body mass during the competition season reflected the negative adaptations in the body composition of the youth soccer players. There was a significant decrease in the LBM in the legs while there was a non-significant decrease in the LBM of the trunk.

This finding further substantiated the contribution of the leg muscularity in the mesomorphic somatotype of soccer players. Our studies have shown that the positive adaptations in the body composition were significantly correlated with soccer performance. Reduction in the % BF and increase in the LBM was significantly correlated with the repeated high-intensity running capability in the players and also with the amount of high-intensity work performed during competitive soccer games (Mukherjee 2008). Therefore, the results strongly suggest the significance of maintaining both game-specific and fitness-related training volume and intensity during the competition season to improve or maintain the positive adaptations in body composition.

Bone mineral density

Soccer involves intermittent high-intensity activities like running at different intensities, sudden accelerations and stops, rapid changes in direction, jumps, kicking and punting that result in significant ground reaction forces on the skeleton. Therefore, soccer can be classified as an impact loading sport (Alfredson, Nordstrom, Lorentzom 1996) involving osteogenic activities (Wittich et al. 1998). Moreover, soccer practice induces positive adaptation of the bone tissue (Vincente-Rodriguez et al. 2004). The results showed a significant increase in the whole body BMD from pre-season to early in-season and also from the early in-season to end mid-season. The BMD of the pelvis did not change significantly from pre-season to the early in-season but showed a significant increase from early in-season to the mid-season. Interestingly, there was a non-significant increase in the BMD of legs with the progress of the competition season. Activities in soccer has been shown to create high peak strains as well as transverse and torsional loads thereby stimulating higher bone mineral acquisition and improved structural properties (Calbet et al. 2001; McNair and Prapavessis 1999). Significant gains in the BMD in the players through the season in our study substantiated this notion. Different aspects of physical activity like muscle force, strain distribution, strain frequency and ground reaction forces cause specific bone adaptations (Skerry 1997). The varying magnitude of the changes in the BMD in different regions of the body of the players in our study can be reasonably suggested to be a reflection of such region-specific adaptations to soccer training. However, a lack of longitudinal data on BMD of youth and adult soccer players limits the scope of comparative analysis of our data. While there was an increase in the BMD whole body, BMD pelvis and the BMD legs, the results showed a non-significant change, rather a decrease in the BMD of the lumbar spine with the progress of the season. This might be due to a relatively low impact loading of the lumbar spine. The majority of the time in soccer is spend walking and low speed running (Bangsbo, Norregaard, Thorsoe 1991; Krustrup et al. 2003) thus generating moderate ground reaction forces (Chang and Kram 1999) that may be insufficient to improve or maintain the BMD lumbar spine (Hetland, Harbo, Christiansen 1993). Comparison of the BMD data of our study with previous studies on soccer players revealed that while the BMD pelvis and the BMD leg in the adult players were either comparable or higher than in the youth professional players, their BMD lumbar spine was lower than the players in our study (Table 8). BMD lumbar spine in runners has been reported to be lower than in the non-runners (Bilanin, Blanchard, Russek-Cohen 1989). However, a comparative analysis of data from the present study and the cited studies on runners and soccer players indicate that the BMD lumbar spine in the soccer players is higher than in runners. Furthermore, the whole body BMD of the soccer players in the present study and in the previous studies (Fredericson et al. 2007) has been found to be higher than in runners.

Similar findings have also been reported in recent studies on younger soccer players at different pubertal stages (Nebigh et al. 2009). This can be reasonably suggested to be due to the additional impact loading activities like sprinting, jumping, turns, accelerations, stops and kicking thereby supporting the osteogenic potential of soccer training. A markedly higher BMD especially in the pelvis and the legs of the adult elite players compared to the youth players (Table 8) strongly substantiates the notion that greater number of years of participation in soccer has a positive osteogenic effect on the bone adaptations in the players. The overall results on the BMD in our study provide strong evidence that the training with respect to the intensity and the impact loading activities involved was favourable for positive bone adaptations in the players.

Conclusion

This is apparently the first study to report the intra-seasonal changes in the body composition profile of youth professional soccer of Asian origin. Moreover, this study also adds to the data on LBM and BMD of which there is a relative paucity in the soccer literature. The results showed that the Asian youth professional soccer players had anthropometric characteristics that were comparable to the adult Asian elite soccer players. However, the adiposity in Asian youth players was higher than both youth and adult elite European soccer players. The changes in the % BF and LBM profiles during the pre-season and the competition season highlights the likely training and fitness implications of including fitness and strength-related training during the competition season for positive adaptations especially in the BF and LBM. While the training and competition load was seemingly inadequate for positive adaptations in the BF and LBM, it was apparently adequate for positive bone adaptations in the players. Based on this evidence, it can be reasonably speculated that there may be different training load thresholds for BF and LBM-related adaptations as compared to the osteogenic adaptations in youth soccer players. Further research in this area might have training and performance implications in soccer players. While the data from this study adds to the evidence to suggest body composition as an important fitness attribute for soccer performance, future studies are needed to elucidate the effects of training-related adaptations in body composition on various aspects of soccer performance.

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UNUTAR-SEZONSKE VARIJACIJE U SASTAVU TIJELA AZIJSKIH PROFESIONALNIH NOGOMETAŠA

Sažetak

Sastav tijela je važan aspect fitnesa nogometa. Postoji oskudica longitudinalnih podataka u vezi međusezonskih varijacija parametara tjelesnog sastava mladih profesionalnih nogometaša posebno u Aziji. Ovo istraživanje procjenjuje prfile sastava tijela azijskih mladih profesionalnih nogometaša (n=20; Mean ± SD, uzrast 17.5 ± 0.3 godina, visina 1.73 ± 0.04 m, težina 67.2 ± 7.5 kg) kroz cijelu sezonu. Težina, postotak tjelesne masti (% BF), težina ostatka bez BF (LBM) i mineralna gustoća kosti (BMD) mladih profesionalnih nogometaša utvrđeni su korištenjem 'dual-energy' rendgenskim apsorpciometrom (DXA) kroz predsezonu, rano u sezoni i na kraju sredine sezone, respektivno. Rezultati su pokazali da mladi profesionalni azijski nogometaši imaj uslične morfološke značajke u usporedbi sa azijskim odraslim elitnim igračima ali su bili nešto niži i slabiji od europskih mladih igrača. Postoji značajno smanjenje ($p < 0.05$) u % BF i značajno povećanje ($p < 0.05$) u LBM za vrijeme predsezone. Međutim, negativna adaptacija za vrijeme natjecanja pokazuje da trenažno i natjecateljsko opterećenje nije bilo dovoljno da unaprijedi ili očuva adaptaciju u % BF i LBM. BMD cijelog tijela značajno raste kroz cijelu nogometnu sezonu. Specifično područje BMD-a – pelvis i donji ekstremiteti pokazali su pozitivnu osteogeničku adaptaciju za vrijeme nogometne sezone. Ovi rezultati pokazuju da se parametri sastava tijela mladih azijskih profesionalnih nogometaša mijenjaju kroz nogometnu sezonu. Ovi se podaci mogu proširiti na temelje usporedbe između različitih populacija nogometaša i dodati perspective istraživanju performansi nogometaša. Potrebne su buduće studije efekata parametara sastava tijela na različite aspekte nogometne izvedbe.

Ključne riječi: *mladi profesionalni nogometaši, Azijati, sastav tijela, nogometna sezona*

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STUDY ON THE OCCURRENCE OF ABNORMAL BODY MASS INDEX (BMI) IN FEMALE STUDENTS

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Original scientific paper

Abstract

The female students are a special group with a very specific status. The body mass index (BMI) is used to determine the normal values of the weight and the degree of fattening in adults aged over 18. The aim of this research is to study the distribution of abnormal BMI in female students. The objects of the study are 1357 female students from Trakia University - Stara Zagora in 2004, 2005, 2007, 2008 and 2009. As a conclusion we can say that the abnormal body mass in female students is a serious problem for the solution of which concrete measures should be taken. We recommend that modules with purposeful complex activities should be included in the curricula of higher schools. The introduction of elective subjects in the secondary and higher school or making personal program for individual study would contribute to the elimination of the abnormal body mass problem.

Key words: *body mass index, female students, obesity*

Introduction

The female students are a special group with a very specific status, determined by its social place – on the border between the working people, who create material and spiritual values, and the social group of pupils. Bearing in mind their age and social status we assume that they are in the prime of their lives, having good physical fitness and esthetic principles. The body mass index (BMI) is used to determine the normal values of the weight and the degree of fattening in adults aged over 18 (World Health Organisation, 2000). According to the World Health Organization (WHO) 19 out of 27 countries have already registered an average BMI above the healthy level of 25 kg/m². If this increase is kept without measures being taken the prevailing obesity percentage will reach 20.1% in all 27 countries of EU in 2020 (Nysom, et al., 2001). On the basis of the data, collected from a study on the health status of the population in March 2001, the BMI for each person aged 18 and over was calculated.According to this index the share of overweight men decreases, but remains high-from 38,5 % (1996) to 32 % in 2001. In women the change is bigger- from 39,5 % to 30 % or almost 10 points, but the relative share still remains high. The overweight people aged between 45-64 are relatively the most – 41 %, and the least are those aged between 18-24 – 8 % (Langenberg, et all., 2003).

Aim

The **aim** of this research is to study the distribution of abnormal BMI in female students. The realization of the aim requires the solution to the following tasks:
1. Measuring the height and the weight of the persons studied (Weiner, and Lourie, 1969).
2. Calculating the individual and average values of BMI.
3. Analyzing the results obtained.

Methods

The *subject* of the study is the abnormal BMI in female students from Trakia University - Stara Zagora. The objects of the study are 1357 female students from Trakia University- Stara Zagora in 2004, 2005, 2007, 2008 and 2009. Anthropometry, alternative and comparative analysis and interview have been applied. The height and the body mass have been measured according to a standard methodology. In order to evaluate the fattening of the persons studied the body mass index has been calculated on the basis of data about height and body mass. The following equation has been used (Malina, and Katzmarzyk, 1999):

$$BMI = \frac{\text{Body mass (in kg)}}{\text{Height (m)}^2}$$

The evaluation has been made according to the following scale:

Underweight	<18.50
Overweight	≥25.00
Pre-obese	25.00 - 29.99
Obese	≥30.00
Obese class I	30.00 - 34-99
Obese class II	35.00 - 39.99
Obese class III	≥40.00

Results and discussion

In the present study the abnormal body mass - underweight, overweight - pre-obese, and I, II, III class obesity have been emphasized. The results about the body mass under the normal (underweight) are showed in graphics on fig.1. The relative share during the four out of five years studied is too high (over 10%). In 2004 it was 11.03%, in 2007-10.84% and in 2008 it was 15.38 which is the highest relative share. In 2009 a high share of underweight female students was registered again -14.34%. In 2005 the relative share was the lowest - 6.44%. The problem about "body mass under the normal" is pushed in the background by the problem of the overweight which is more discussed. The former is not paid enough attention because of the social element which, in most cases, causes it. The underweight can be due to under-nutrition or malnutrition, to poor financial means or a desire for reduction of the body mass. The under-nutrition, the low intake of energy and proteins weaken the immune functions and deficiency diseases develop. Serious health problems may appear during a systematic starvation without permanent control. In the last decades an increase in the diseases, related to systematic under-nutrition or malnutrition during teenage, has been observed (Milewicz, et al., 2005, Yumuk, 2005). These are the so called nutrition disorders known as anorexia nervosa and bulimia nervosa, which are observed in young secondary school girls who practice under-nutrition on purpose. These are multifactor diseases difficult to be put under control (Vidović, 1998). In 2004, 2005 and 2007 the conversations with the underweight persons studied made clear that most of them did not want to change their body mass regardless of their emaciation. Only few of them prefer having a normal body mass. This fact shows they underestimate the danger of serious health problems. In 2008 and 2009 a sharp change in the students' desire to change their body mass was established. They expressed their preferences for esthetical shaping of the body by "covering it" with muscle mass. In most of the cases the persons studied look for expert help to realize their purposes (Благосклонная, et al., 2003).

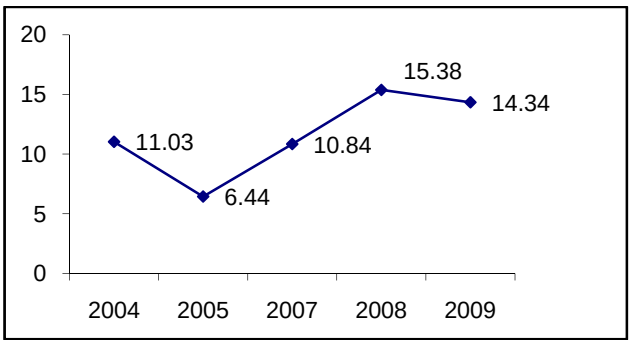

Figure 1. Relative share of the underweight persons studied

The category "overweight" takes up a particular place in the evaluation system of the body mass. It is a "red light" warning of the danger of obesity. Taking control over the overweight is a preventive healthy measure, a prerequisite for good health. In the present study the following relative shares of overweight (pre-obese) female students have been registered: for 2004- 14.96%, for 2005-12.6%, for 2007-13.86%, for 2008-8.97% and for 2009-11.46% (fig.2). The high values hide a real threat for the overweight (pre-obese) female students to go into the next category - obesity. During the conversations with the female students from this group they expressed their desire to shape an esthetic body and to correct their body mass. The persons studied share their disappointment with their unsuccessful experience to solve this problem by themselves. Very few overweight students do not show any interest in the problem.

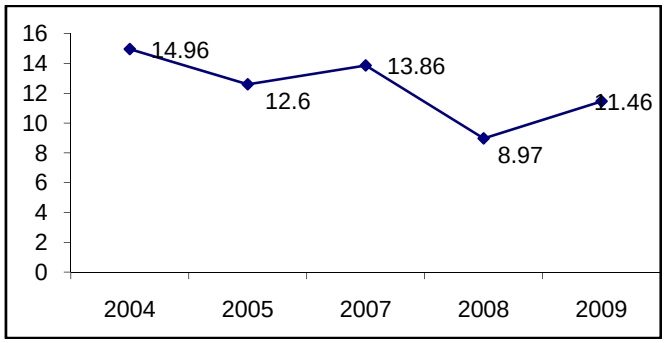

Figure 2. Relative share of the overweight persons studied (pre-obese)

The obesity represents an excessive accumulation of fatty tissue in the organism. Depending on the extent of this accumulation the state is classified as overweight or obesity indicating different degrees of health risk. Obesity is a very serious health problem for Bulgaria. It is one of the most widely occurring risk factors affecting nearly half of our population. The data in the persons studied shows occurrence of this risk factor among the female students too. The results in the present study show a higher relative share of the persons studied in 2005 - 7.19% compared to these in 2008- 5.13% and in 2009- 4.46%. In 2004 and 2007 the results are almost equal (respectively 3.15% and 3.01%) (figure 3).

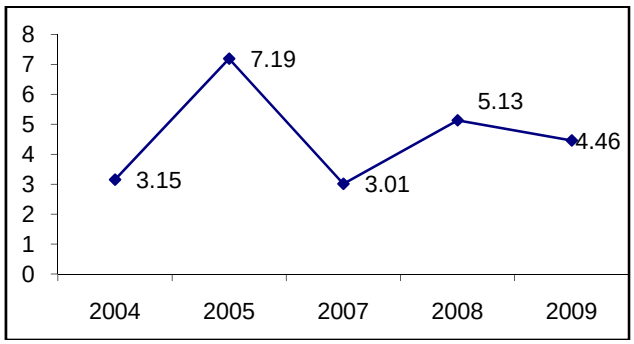

Figure 3. Relative share of the persons studied with "I class obesity"

When commenting data about obese young women even the presence of only one case is alarming. In the present study only in 2004 there were no registered female students with II class obesity. In 2005 they were 2.08%, in 2007 -1.81% in 2008 - 1.29%. The relative share of II class obesity in 2009 was high - higher than the relative shares of the previous two years considered together (3.18%) (figure 4).

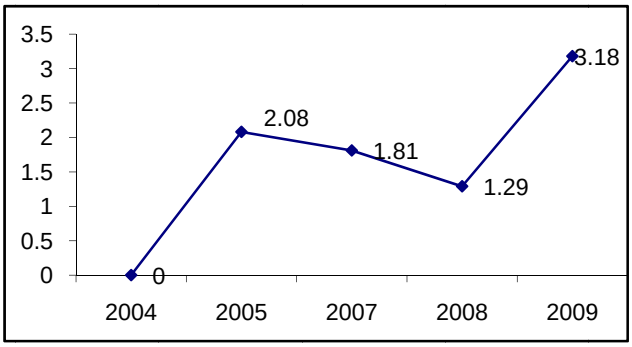

Figure 4. Relative share of the persons studied with "II class obesity"

In 2005 and 2008 persons with III class obesity were not registered. In 2004 1.57% of the persons studied were with a high health risk 1.81% -in 2007 and 0.64%- in 2009. Logically follows the analysis of the summarized results about *abnormal body mass* including: body mass under the normal, body mass above the normal, I class obesity, II class obesity and III class obesity and about *overweight* including: body mass above normal, I class obesity, II class obesity and III class obesity. High increase in the relative share of the abnormal persons studied is observed. In 2004 it was almost the same as in 2008 - 30.71% and 30.77% respectively. It was lower in 2005 - 28.3%, and in 2007 it was 29.52%, the highest- 34.08% being in 2009 (figure 5). The average value of the relative shares for the persons studied from this group is very high - 30.68%. This means that 3 out of 4 of every 10 female students are included in this group.

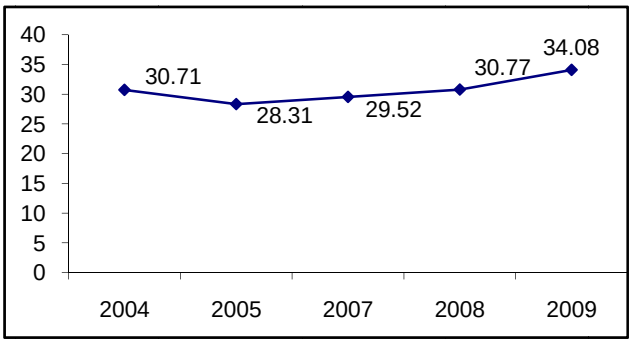

Figure 5. Relative share of the persons studied with abnormal BMI

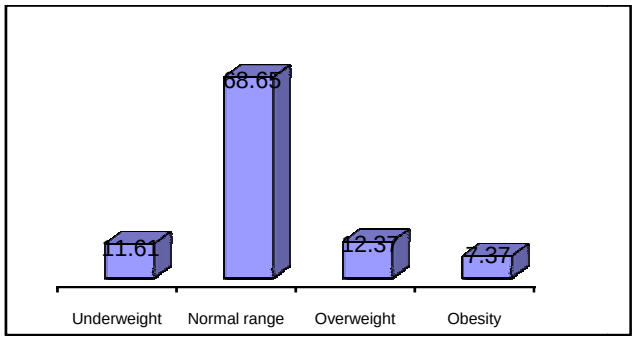

Figure 6. Average values (in %) of BMI of female students for the period 2004-2009.

The results obtained during the last 3 years have shown a trend towards increase in the underweight female students. In the overweight comparatively stable values were mentioned in 2004, 2005 and 2007. There was a slight decrease in 2008 and another increase in 2009. The fact that the relative shares of underweight female students and of overweight ones in 2008 were almost the same, 15.38% and 15.39% respectively, is interesting (figure 7).

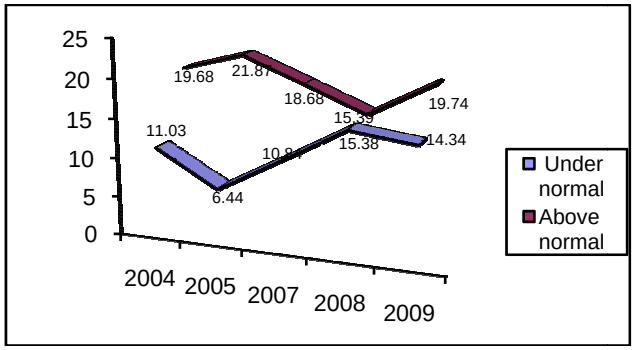

Figure 7. *Dynamics of the relative share of female students with body mass weight under normal and above normal for the period studied*

Conclusions

As a conclusion we can say that the abnormal body mass in female students is a serious problem for the solution of which concrete measures should be taken. We recommend that modules with purposeful complex activities should be included in the curricula of higher schools. The introduction of elective subjects in the secondary and higher school or making personal program for individual study would contribute to the elimination of the abnormal body mass problem.

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ISTRAŽIVANJE POJAVE PRETJERANOG INDEKSA TJELESNE MASE (BMI) KOD STUDENTICA

Sažetak

Studentice su posebna skupina s vrlo specifičnim statusom. Indeks tjelesne mase (BMI) koristi se za određivanje normalne vrijednosti težine i stupnja uhranjenosti kod odraslih u dobi od 18 i više godina. Cilj ovog istraživanja je proučavanje pojave prekomjernih parametara BMI u ženskih ispitanika - studentica. Istraživanje je realizirano na 1357 studentica Trakijskog Univerziteta - Stara Zagora u 2004, 2005, 2007, 2008 i 2009 godini. Kao zaključak može se reći da je pretjerana tjelesna masa u ženskih ispitanika ozbiljan problem za čije se rješenje treba poduzeti konkretne mjere. Preporučuje se module s prethodno pripremljenim sadržajima i modalitetima aktivnosti uključiti u programe viših škola. Uvođenje izbornih predmeta u srednjim i višim školama ili izrada osobnih programa za pojedine studije bi pridonijeli smanjenju prekomjerne tjelesne mase.

Ključne riječi: *index tjelesne mase, studentice, gojaznost*

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ANALYSIS OF CERTAIN INDICATORS OF THE LOAD IN THE PLAY OF WING IN TODAY WATER POLO

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Original scientific paper

Abstract

A representative sample of 136 entities (quarters in water polo) has been taken to register the total activity of the wing during the international games of the Adriatic Water Polo League in the season of 2009/10. Various types and quantities of movement have been registered for different intensity, duration and frequency of events both in the horizontal and vertical phases of game. A sample of variables consisting of 21 originally measured and 8 derived variables has been used. For final multivariate analysis 11 variables have been retained. Data processing methods have been brought into accord with the aims of this research, and the basic statistical parameters as well as distributions of all the measured and derived variables have been calculated. Factor analysis under component model has been carried out, whereas the final factor solution has been determined using "Oblimin" rotation. Standard SPSS package has been used for data analysis. The results of this research clearly and definitely show that it is possible to determine the latent sources of variability related to wings movements during a water polo match (number of actions, frequency, levels of load and the amount of movement measured in meters) in vertical as well as in horizontal phase in the game. From a wider choice of variables for measuring guard (back) activity it is possible to extract a sub-group of variables which describe the important target aspects of player load in water polo with satisfactory factor validity. The measuring instrument, with respect to the battery of directly registries and derived indicators according to the obtained results, can be recommended for use in measuring of different aspects of load of any water polo player (role), which gives scientifically importance of this work. The practical importance of this work lies in the possibility of direct application of this work's results to practice, planning, programming, player selection and specialization for the wings role in water polo.

Key words: *water polo, wing, levels of load, factor analysis*

Introduction

Water polo, as an activity, belongs in the category of polystructural complex motions. Motions, in all of sports activities, is possible observe and analyze from two basic standpoints. Energetically standpoint that analyze quantity of movements, intensities and duration, as well informaticaly that analyze techniques', tactics, strategies and theoretical acquirements of the players. Substantial, both, components always are present together and are divisible in the real conditions of the game, but their mutual relationships are different in different situations.

Either training must start with information's about two essential components: Aim of these changes and Characteristics of those we want to change. How this two information would be served for programming of training, they must be explicitly defined to the objective characteristics of those which we changes. Practice in today's pedagogy is in contrast with these principles. Methods and modalities of the work applied in training are possible to divide into: Situational (situational training) and Partial (accessory training). For either type of training, on the base of objective analysis, it is necessary determinate over cover coefficients that are solitary condition for the regular training construction.

Regarding task, and their roles in team, this relation varies, what consequently means different trainings for different positions and roles in the game (Lozovina, V., 1984; 1995.). In the structure of the game 35% of the time water polo player spends in horizontal phase (all swimming's in all intensities' during the game) as well as 65% in vertical phase (vertical position organized by leg activity) solved technical and tactical tasks (Lozovina, 1984). Water polo plays 6 players in the field and goal-keeper. Typical for water polo game is hers characteristically play course. After attempt, but unrealized, counter-attack, it is usual to organize positional attack to find a chance for realization. In this situation one player takes a position on 2-3 m in front of the rival's goal, half left or right regarding the center of the goal. Two wings take a position sideways 3-4 m from goal-out line, 3m away from goalpost. Their dominant role is to transfer the ball to center forward, as well as prevent the contra attack of rival's after ball possession losing. Next tree players are attackers from second line (external attackers) that individually or mutually by swimming try to create space advantage for receive, pass the ball or shoot on rival's goal. The total activity of the guard during the international championships matches in the first division of the Adriatic water polo league 2008/09 has been taken to register.

Scientific investigation, identical to this, have had been performed by Lozovina at al. (2000) against the matches of Croatian I. water polo league, according old water polo rules, in that time existing, in favor of duration of the game was 4X9 min. New rules significantly change the play. It is to believe that the parameters which have defined the play of the guard in 2000 in today's water polo look quite differently. This sense set forward this research.

Preliminary investigations

Authors Lozovina & Pavičić (1985; 2000.) establish methodology for estimation of vertical and horizontal component in the game of water polo. With a similar problem in the sense of the modeling of activity characteristics' of water polo players in vertical phase of the game during the play have be involved in Bratuša, Matković, & Dopsaj (2002; 2003). Lozovina & Pavičić designate the model for analysis of the load in situational conditions regarding intensities, frequencies and time spent in the game as determinant of a load equivalent in the game (Lozovina at al., 2002; 2003; 2004; 2006). Authors and associates have been elaborated and published all five positions (role in the game). In article „Analysis of indicators of load during the game in the activity of the center in water polo", authors identify that existed resources of variability affiliated with intensity on the position of the center forward.

In intensity is perceived presence of two aspects. One expressed across the quantity of actions and second as engagement level. These two aspects defined first and second factor assigned in this study. As a third latent dimension, arise the time spent in the game. In the article, „Analysis of indicators of load during the game in activity of the second line attacker in water polo", authors defined three factors where the latent structures are in relations with intensity of activity and types of actions. In intensity, authors defined two aspects: quantity of actions and level of activity. In the article, „Analysis of certain indicators of the load in the play of the wing in water polo", authors defined four factors. First defined as an intensity of activity, second as frequency of actions in vertical position, third as extensity of activity and fourth as a time spent in vertical phase of the game. In the article „Analysis of some indicators of the load in the play of heavy defender in water polo "authors acquire three latent structures and defined them as: quantity of actions, intensity of activity in vertical position and extensity of activity in horizontal phase expressed across slightly swimming. Series of other articles mentioned authors in addition elaborate theme field directly associated with subject of this investigation. In football several authors analyzed modalities, quantities and intensities of the player's movements during the game. Castagna at al., (2003 according to Bašić, 2005) from presented results observed that football players from Japan during the game run off a distance between 8,680-11,527 m. Analyzing the younger categories of football players (11-12 years) take out information that in the game in duration of 60 min. young players run off about 6200 m, from what 5,5% less in the second half time regarding first. During the game the players were standing in the place 11% of totally time spent in the game. At the movies speed higher than 18 km/h they make 18 duels in average duration of 2, 5 s with average break of 120 s between two duels. About 9% of the game time players were working on a high level of intensity. Football game comprises of 1000 – 1200 movement changes. Activity changes happen every in 5–6 s short intervals. Movements consist of a walk (25%), easy running (37 %), submaximal running (20%), running in sprint (11%), backwards running (7%) (Jeffreys, 2004, according to Bašić, 2005). In handball, differences between extensity and intensity of cyclic activities of handball players, on several playing positions and roles have been analyzed by Šibila, Vuleta & Pori (2004). Data base were collected by SAGIT-system with computer software supporting. Output data were processed with chosen methods from programs Excel and SPSS. Statistically significant differences between groups were determinate regarding average distance pass through the game. Mostly run the wings, hence external players, some less circuit attacker and at least goalkeeper. Differences are registries for the average tie of moving in average speed in all of rapidity categories. For second rapidity category were not registries differences between wings, external players and circuit attackers, but these tree groups are significantly different from goalkeepers. Statistically significant differences are registries in all four groups according to average moving speed. From provide it is obviously that the data collection is collected by different operations, as well as the methodologies of data processing are very similar.

Aims and importance

Aims of this Work will be accomplished through the determination of basically parameters of the load in the play of the wing in water polo. These parameters will be established on the base of objectively registered activities on the representative sample of entities. Hence, in this work, additional aim is define treatments for data collecting for such measurement and set out validity of that instrument. It can be presumed that objective description of activity in the play of wing in water polo is possible provided really register of the: various types, quantities of movements, upon different intensity's, durations, and frequencies, as wall in horizontal therefore in vertical phase of the game. Based on that we appoint hypotheses: a) Presumed that it will be possible determine latent sources of variability affiliated with a number of actions (frequencies) in the play of the wing in water polo, b) Presumed that it will be possible determine latent sources of variability affiliated with a levels of the load in the play of the wing in water polo, c) Presumed that it will be possible determine latent sources of variability affiliated with a quantity of the movements in the play of the wing in water

polo, and d) Presumed that from a wider choice of variables provided for measuring the activity of the wing it will be possible extract a subset with satisfactory factor validity. Importance of the work manifested in the practical implementation of the results as well as in a scope of selection, routing and sports specialization such in planning and programming the training for „workplace“ wing in water polo.

Methods

Experiment description

In the framework of implemented experiment the aim was objectively measured the quantity and intensities of players activity in the position of the wing in water polo. That is achieved by registration, respectively monitored of player's activity on international games of Jadran-water polo league in the season in 2009/10. All the games were played in Split. Registration and data sampling was performed by five qualified surveyors, professors of kinesiology, water polo trainers with over annually experience. In the game, in the time whose player spend in the play, was recorded all movements, intensity's and positions of the body in horizontal and vertical positions. The criteria for estimation of work intensity, respectively burden: maximal, sub maximal and slightly, was determined, on the base of swimming speed in the course of actions takeoff. Measurers were trained, measuring the same player on 10 games. Experiment is carried out after completely concordance among surveyors was acquired. They were positioned on the high placed stand which enabled optical coverage of the whole playing field. Standard water polo markers (2 m, 5 m, goal out line, center, etc.) enabled precise recording of swimming distances at various intensities of players. Each official recorded all activities of their designated player. At every moment, they had view of the official time clock which showed a down count of the official, clean game time and smaller time clocks that shows ball possession and attack time. Each official consecutively recorded every action taken by his designated player. In case a player was thrown out of the game or has not been in the game (change of players) time was measured when the player exited the game and reentered the game.

Sample of entities

Entities or basic carriers of information in this experiment are part of the water polo game. According to rules, water polo is played in quarters of 8 minutes each (clean game time) or about 17 minutes real time per quarter. Each quarter starts the same way by swimming toward the ball which is placed in the center of the playing field. The quarter ends with an audible signal. Between the quarters are passive pauses (2 min., 5 min., and 2 min.). From these reasons, one quarter is representative of one whole, and methodologically justified to use as an entity for measurement. Sample of entities in this investigation consist of 136 water polo quarters.

Sample of indicators

Activities are recorded by the quantity and intensity of activity and movements made by wing. Frequencies and actions are recorded by type and the quantity of passed distances of the playing field, recorded in meters. Various activities are realized by various techniques of swimming (crawl, backstroke and breaststroke) in various intensities in modalities (easy, sub maximal and maximal). The number and duration of duels are measured as well as time spends in the game with players more or less. Movements and intensities were measured in horizontal and vertical positions with respect to the water surface. Based on measured source variables, new variables were produced which relate to intensity, frequency, and time spent in the game with a player more or less, the total number of actions and total quantity of distance swam. Duel is the time spent in contact with the opponent and is defined as over maximal load in the vertical position. Time spent in the game with a player more or less is defined as maximal load in the vertical position. Time spent with a player more or less is measured as real time in the game spent with an uneven number of players on either side.

Table 1. Authentic registries indicators

FKRMAX	frequency unit crawl, maximal
FLEDMAX	frequency unit backstroke, maximal
FKRSMX	frequency unit crawl, sub maximal
FLEDSMX	frequency unit backstroke, sub maximal
FKRLAG	frequency unit crawl, easy
FLELAG	frequency unit backstroke, easy
FPRLAG	frequency unit breaststroke, easy
FDUEL	frequency of duels
FIGVIS	frequency of actions with players more
FIGMAN	frequency of actions with players less
MKRMX	distance in crawl in maximal speed in meters
MLEDMX	distance in backstroke in maximal speed in meters
MKRSMX	distance in crawl in sub maximal speed in meters
MLEDSMX	distance in backstroke in sub maximal speed in meters
MKRLAG	distance in crawl at easy speed in meters
MLEDLAG	distance in backstroke at easy speed in meters
MPRLAG	distance in breaststroke at easy speed in meters
MDUEL	time duration of duels in seconds
SIGVIS	time duration with players more in seconds
SIGMAN	time duration with players less in seconds
SUKUPNO	total time spent in play in seconds

Data analysis

Methods of data processing are harmonizing with the aim in this investigation. On the measured sample basic statistical parameters and distributions of measured and derived indicators are calculated, namely: arithmetical mean (A.S.), standard deviation (S.D), Kurtosis (K.) and Skewness (S.), minimal and maximal result of all of indicators. With intention to identify latent structure calculated was: intercorelations matrix, factor analysis under the component model was performed, the communalities of all indicators was calculated, on the base of characteristics Eigen values of intercorelations matrix the percent of explained variance was calculated for any retained factor an cumulative, final factor solution is fixed by Oblimin solution, correlations between factor in Oblimin solution were calculated. For analysis standard statistical SPSS package were used.

Table 2. Derived indicators

FMXSMX=FKRMX+FLEDMX+FKRSMX+ FLEDSMX Total of frequency units in crawl and backstroke in maximal and sub maximal
MMXSMX=MKRMX+MLEDMX+MKRSMX+ MLEDSMX Total distance in meters in crawl and backstroke at maximal and sub maximal
FLAGAN=FKRLAG+FLEDLAG+FPRLAG Total frequency units in crawl, backstroke, and breaststroke at easy
MLAGAN=MKRLAG+MLEDLAG+MPRLAG Total distance in meters in crawl, backstroke, and breaststroke at easy
FIGVM=FIGVIS+FIGMAN Total frequency with players more or less during the quarter
SIGVM=SIGVIS+SIGMAN Total seconds played with players more or less
FAKCIJA=FMXSMX+FLAG+FIGVM Total frequency units of distances at sub maximal, maximal, and easy plus frequency with players more or less
METARA=MMXSMX+MLAGAN Total distance in meters in maximal, sub maximal and easy intensities

Results and discussions

Table 3. Central and dispersive parameters of all of measured indicators

Variable	A.S.	S.D.	S	K	Min.	Max.
FKRMAX	3,37	2,96	1,49	3,03	0	17
FLEDMAX	,26	,71	3,75 *	15,92*	0	4
FKRSMAX	8,18	4,49	,83	1,29	0	26
FLEDSMAX	,95	1,33	1,52	1,80	0	6
FKRLAG	6,55	4,35	,81	,47*	0	20
FLELAG	1,87	1,97	1,52	2,63	0	10
FPRLAG	1,64	2,04	1,97*	5,48*	0	12
FDUEL	1,68	2,16	1,68	2,73	0	10
FIGVIS	1,63	1,23	,93	1,70	0	7
FIGMAN	1,16	,95	,42	-,47*	0	4
MKRMAX	32,51	31,07	1,63	3,15	0	166
MLEDMAX	,88	2,58	4,54*	26,11*	0	20
MKRSMAX	98,96	60,70	1,23	3,51	0	398
MLEDSMAX	3,63	5,46	1,84	3,22	0	25
MKRLAG	57,07	41,58	,84	-,13**	0	165
MLEDLAG	8,10	9,31	1,92	4,55*	0	51
MPRLAG	7,87	9,46	1,44	1,99	0	47
MDUEL	6,49	9,11	2,03*	4,39*	0	46
SIGVIS	23,77	18,05	,45	-,69	0	69
SIGMAN	17,68	16,59	,65	-,20*	0	74
SUKUPNO	338,13	121,42	-,35	-,99	24	480
FMXSMX	12,76	6,98	,92	1,68	0	42
MMXSMX	135,98	72,82	,90	1,49	0	429
FLAGAN	10,06	6,23	,79	,26	0	29
MLAGAN	73,03	49,14	,76	-,22	0	201
FIGVM	2,79	1,68	,55	,48	0	9
SIGVM	41,45	27,28	,36	-,64	0	113
FAKCIJA	25,61	10,66	,74	1,90	2	73
METARA	209,01	86,32	,51	,46	15	501

*** =** aberration from normal distribution

In Table 3 are display statistical parameters of all measured and derived indicators: arithmetical means, (A.S.), standard deviations (S. D.), Kurtosis (K.) and Skewness (S.) of distributions, minimal and maximal results. By inspection of Table 3 is establish that the indicators FLEDMAX, FPRLAG, MLEDMAX, MKRLAG, MLEDLAG, and MDUEL have pronouncedly deviation from normal distribution, due to their rare prevalence in the game. Minimal results showed that almost all direct measured indicators (underived) have results and null (0), respectively did not appear in every monitored quarter. Extremely high frequency have the indicators by which is monitored activity crawl maximal and crawl sub maximal as well as number of duels. High frequency is noted in indicators which measured play with player more or less. Statistics of en masse derived indicators showed that all of them have normal or approximate normal distributions. For further and final multivariate analysis 11 indicators are retain.

Table 4. Indicators retained for final analysis

FDUEL	frequency of duels
MDUEL	time duration of duels in seconds
sigvm	Total seconds played with players more or less
SUKUPNO	total time spent in play in seconds
fmxsmx	Total of frequency units in crawl and backstroke in maximal and sub maximal
mmxsmx	Total distance in meters in crawl and backstroke at maximal and sub maximal
flagan	Total frequency units in crawl, backstroke, and breaststroke at easy
mlagan	Total distance in meters in crawl, backstroke, and breaststroke at easy
figvm	Total frequency with players more or less during the quarter
fakcija	Total frequency units of distances at sub maximal, maximal, and easy plus frequency with players more or less
metara	Total distance in meters in maximal, sub maximal and easy intensities

By analysis of central and dispersive parameters it is possible to conclude: During the game wing in the play spends 22, 54 min of a clean time, thus, full two quarters of the 8 min of the clean play and 6, 54 min over. That is a great quantity of the time in respect to great intensities and loads of the wing during the game. Usually, I- division time's dispose of more than two good and good trained wings, who changed during the game providing own maximum in every moment of the game. During the game wing swam average 836,04 m from what: In sub maximal and maximal intensity, totally, 543, 92 m, respectively pro quarter average 135, 98 m; In light intensity during the game wing swam 292, 12 m, respectively pro quarter average 73, 03 m; In the play with player more or less (vertical component) wing in the game spent 165,8 s, respectively, 41,45 s average pro quarter; In duels wing spend average 25,96 s or 6,49 s average pro quarter; in vertical position at maximal load (player more or less) and over maximal load (duels) wing in the game spent totally 165, 80 s. Other vertical or quasi vertical positions, which wing during the game proceeds, are treated as positions upon light load, are not especially reiterated nor processed in this work.

Table 5. Correlation matrix

	FDUEL	MDUEL	sigvm	SUKUPNO	fmxsmx	mmxsmx	flagan	mlagan	figvm	fakcija
MDUEL	0,91									
sigvm	-0.01	0,01								
SUKUPNO	0,23	0,20	0,50							
fmxsmx	0,30	0,28	0,10	0,54						
mmxsmx	0,25	0,21	0,24	0,53	0,87					
flagan	0,41	0,34	0,14	0,58	0,19	0,09				
mlagan	0,25	0,21	0,22	0,57	-0.03	-0.04	0,93			
figvm	-0.04	-0.01	0,88	0,50	0,14	0,26	0,35	0,42		
fakcija	0,43	0,38	0,28	0,77	0,79	0,66	0,77	0,68	0,34	
metara	0,36	0,30	0,33	0,77	0,71	0,82	0,54	0,53	0,34	0,86

Intercorrelations matrix of reduced indicators reunion was calculated (Table 5). Inspection of correlations matrix display big range of indicators connections, from null (0) correlation of indicator FDUEL with indicators flagan and fakcija as equally null correlation of indicator flagan with indicators sigvm, fmxsmx and mmxsmx, until significantly great values of connection of indicator FDUEL with indicator MDUEL, indicator SUKUPNO with almost all indicators except FDUEL and MDUEL. Group of indicators SUKUPNO, fmxsmx, mmxsmx, flagan, mlagan and fakcija are high correlated with indicator METARA.

Table 6. Initial Eigen values, percent of variance, cumulative variance retained factors by GK criterion

Initial Eigenvalues	% of Variance	Cumulative %
5,21	**47,37**	**47,37**
2,02	**18,33**	**65,71**
1,81	**16,47**	**82,17**
1,18	**10,71**	**92,88**
0,28	2,56	95,45

From the Table 6 is possible to conclude that in the accordance of GK criterion four components' explain 92, 88 % of variance from total system. First main component explain 46, 37 % second 18, 33 % third 16, 47 % and fourth 10, 71% of variance. First principal component are good defined with high projections of all of indicators, except indicators FDUEL, sigvm, mlagan and figvm. This factor, dominantly, and by high coefficients of participation defined indicators fakcija, metara and SUKUPNO (.95, .93, .85). They are added, with somewhat lower, but high coefficients indicators fmxsmx, mmxsmx, flagan and FDUEL (.71, .70, .70, .51). Second principal component are bipolar, and defined by relatively high projections of indicators figvm and sigvm (.72, .70) with positive omen, and with indicators FDUEL and MDUEL (-.67, -.65) with negative omen. Second principal component can be defined as those which are responsible for variability in variables who's talking about intensities in vertical phase of the game. Third principal component are also bipolar and defined by indicators mlagan and flagan (.74, .59) with positive omen and with indicators mmxsmx and fmxsmx (-.66, -.64) with negative omen, thus, by frequencies and meters swam in light intensity and opposite orientated frequencies and meters swam in sub maximal and maximal light intensity.

Fourth principal component is defined by indicators MDUEL, FDUEL, sigvm and figvm (.56, .48, .47, .42). It is possible to interpret it as that which describes intensities in vertical phase in the play of the wing in modalities over maximal and maximal.

Table 7. Pattern matrix in Oblimin solution

	FAC 1	FAC 2	FAC 3	FAC 4	H2
FDUEL	0,03	-0,02	0,04	**0,96**	0,95
MDUEL	-0,03	0,04	-0,03	**0,99**	0,96
sigvm	-0,05	**0,99**	-0,04	0,03	0,94
SUKUPNO	**0,48**	0,32	**0,47**	-0,05	0,81
fmxsmx	**0,99**	-0,10	-0,12	0,06	0,94
mmxsmx	**0,98**	0,07	-0,21	0,02	0,94
flagan	0,04	-0,08	**0,94**	0,12	0,95
mlagan	-0,15	0,04	**0,99**	0,00	0,96
figvm	0,00	**0,97**	-0,03	-0,01	0,93
fakcija	**0,67**	0,04	**0,46**	0,11	0,93
metara	**0,75**	0,08	**0,39**	0,01	0,92

Communalities (h2) of all indicators are high and in the range from 0,81 (SUKUPNO) to 0,96 (MDUEL and mlagan). From the pattern matrix in Oblimin solution (table 7), after slantwise rotation, it is perceive simplicity of the solution. On the first factor the biggest projections have indicators: fmxsmx, mmxsmx, metara, fakcija and SUKUPNO (.99, .98, .75, .67, .48). This factor are dominantly describe by indicators anticipated for measuring the intensity of sub maximal and maximal swimming throughout the number of actions, quantity of the swam meters and the time spent in the game. This factor we entitled „quantity of actions, or action". Second factor is dominantly defined by high projections of indicators sigvm and figvm (.99, .97). It can be defined as „intensity of the activity in vertical phase (M)", hear expressed trough the modality on the maximal level. If in this constellation of the factor, we demand a structure of the wing, it is possible to describe him as a wing with small number of the duels in the proportion with a time spent in the game and with a great number of played players more or less. Third factor defined high projections of indicators: mlagan, flagan, SUKUPNO and fakcija (.99, .94, .47, .46). Other indicators have neutral influence on this factor.

Table 8. Factors correlations

	F1	F2	F3
F2	0,27	1,00	
F3	0,26	0,26	1,00
F4	0,28	-0,01	0,27

Dominant attribute of this factor, in the context of indicators projections, are „intensity (extensity) of activity in horizontal phase“, her expressed thru the light swimming over which this type of the wing achieved totally swam meters, total frequency of actions, during the time spent in the game. If in such constellation of factor we search for structure of wing, it is possible to define him as untypical wing, who uncommon or never enter in the duels, swam relatively slight and do not forced counterattack in high intensities. Fourth factor, dominantly and by great participation coefficients defined indicators MDUEL and FDUEL (.99, .96). This factor we defined as „intensity of activity in vertical phase in the game (NM)“, here's expressed trough the modality over maximal (duels). In the constellation of the fourth factor we can recognized the wing which can be defined as a wing-guard who play against opponents centre forward when opponent team are in positional attack, from where generate the total time spent in the game. Questionable is play quality that type of wing in his defense task. Correlation between factors are low what suggest that all of them exited in own sense. According to the aims appointed in this research, results approved that implemented indicators set are very good and cowered main subject in this investigation. It is affirm that existed resources of variability affiliated with intensity in the play of the wing. Two aspects existed in the intensity. First, expressed through the quantity of actions, which defined first factor assigned in this investigation, and second assigned as a level of engagement, defined by second, third and fourth factor assigned in this research. It is interesting to notice that did not existed correlations between those structures about what speak, practically nullcorrelations between factors.

Conclusion

On the base of the objective registration on the representative sample of 136 entities and analyze of the central and dispersive parameters of all measured and derived indicators realized is the first aim set up in this research. Determined are the basically parameters of the load in the play of the wing defined by different types and quantities of the movements trough different intensities, frequencies and durations, as well in horizontal therefore in vertical phase of the game. For the purposes of perceived deviations from the normal distributions for multivariate analysis it was not possible applied all of directly recorded indicators. For the final, multivariate, analysis was retained 11 indicators, normal or approximately normal distributed. The latent space, given by factor analyses, resulted with a for factors explaining 92,88% of variance, where, first factor explaining 47,37% , second 18,33%, third 16,47% and fourth 10,71% of variance from the total system. From the pattern matrix in Oblimin solution, after slantwise rotation, it is perceive the simplicity of the solution which enabled defining and nomination of the latent structures. Given factors nominated as: „quantity of actions, or action“, „intensity of the activity in vertical phase of the game (M)“, „intensity (extensity) of activity in horizontal phase of the game“ and „intensity of activity in vertical phase in the game (NM)“, satisfactorily describes four different manners in the play of the wings in water polo. All four hypotheses appointed in this research are confirmed. Defined are the resources of variability affiliated with the number of actions (frequencies), resources of variability affiliated with a levels of the load and quantity of the movements in the play of the wing as well in horizontal so in vertical phase of his play. Hypothesis that from a wide selection of indicators for measuring a total activity of the wing it is possible to set a subgroup of indicators with satisfactory factor validity which describes all important activity aspects of the wing in water polo, is affirm in this investigation.. The measuring instrument, constructed for data collecting, according the given results, can be recommended for using in measuring of different aspects of the load of any player, what gives scientifically importance of this work. Practical importance of this work it's in the possibility four direct applications of given results to the sport practice, planning, programming, selection and specialization for a wing role in water polo.

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ANALIZA ODREĐENIH INDIKATORA NAPREZANJA U IGRI KRILA DANAŠNJEG VATERPOLA

Sažetak

Na reprezentativnom uzorku sačinjenom od 136 entiteta (četvrtine u vaterpolu) registrirana je ukupna aktivnost u igri krila. Istraživanje je provedeno na utakmicama Jadranske vaterpolo lige u sezoni 2009/10. Mjereni su i registrirani različiti tipovi i količine kretanja pri različitim intenzitetima, trajanjima i frekvencijama u horizontalnoj i vertikalnoj fazi igre. Uzorak varijabli sačinjavala je 21 direktno mjerena varijabla i 8 izvedenih. Za konačne multivarijatne analize ostavljeno je 11 varijabli. Metode obrade podataka usklađene su s ciljem istraživanja. Izračunate su bazični statistički parametri i distribucije svih mjerenih i izvedenih varijabli. Izvršena je faktorska analiza pod komponentnim modelom a konačna faktorska solucija određena je Oblimin rotacijom. U obradi podataka korišten je standardni statistički SPSS program. Rezultati ovog istraživanja jasno pokazuju da je moguće definirati latentne izvore varijabiliteta (broj akcija, frekvencije, nivoi opterećenja i količine kretanja mjereno u metrima) i povezati ih sa igrom krila tijekom vaterpolske utakmice kako u vertikalnoj tako i u horizontalnoj fazi igre. Iz šireg izbora varijabli za mjerenje aktivnosti krila tijekom utakmice moguće je izvući podgrupu varijabli koje s zadovoljavajućom faktorskom valjanošću opisuju sve značajne a ciljane aspekte igre krila. Mjerni instrument odnosno baterija direktno registriranih i izvedenih indikatora prema dobivenim rezultatima može se preporučiti za korištenje i mjerenje različitih aspekata opterećenja bilo kojeg igrača u vaterpolu u čemu se ogleda i znanstveni značaj ovog rada. Praktični značaj ovog rada ogleda se u mogućoj primjeni rezultata kod planiranja i programiranja treninga, selekcije, usmjeravanja i usavršavanja za " radno mjesto" krila u vaterpolu.

Ključne riječi: *vaterpolo, krilo, razine opterećenja, faktorska analiza*

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RELATIONSHIP BETWEEN BIG FIVE PERSONALITY MARKERS WITH SITUATION-RELATED PERFORMANCE AT TOP CROATIAN BASKETBALL PLAYERS

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Abstract

Determining the relationship between situational performance indicators and psychological characteristics of the top Croatian basketball players, could provide guidance for the selection of top quality senior basketball players, as same as for better coaching work. The aim of our study was to determine the relationship between the standard and derived coefficients of situational related performance in basketball and the dimensions of Big Five personality characteristics, measured with Croatian version of the IPIP50 questionnaire. The final sample of participants (74 basketball players) is selected from the initial sample of 107 players from nine men's senior basketball teams in A-1 Croatian men's basketball league in championship 2006/2007. The results showed statistically insignificant canonical correlations between a Big Five personality characteristics and set of situational performance indicators in basketball. However, relatively high value of the canonical correlation between two sets of data, indicating the probability that the correlation could be statistically significant, if the number of participants was slightly higher.

Keywords*: coefficients, standard, derived, Big Five, canonical correlation*

Introduction and the aim

Theories of successful play, based on actual quality, become more and more important nowadays because they directly correlate with successful selection of options in a given game situation and with competitive results. More and more, coach experts seek various, but linked analyses of the sport itself, then of game events, matches, positions in the game, individual and/or team play, motion structures and physiological-anatomical analyses of certain sport (Dizdar, 1997). This paper analyses the 12 FIBA official standard indicators of situation-related efficiency (in basketball practice known as indicators of performance) and 7 derived indicators of situation-related efficiency of top basketball teams that took part in Croatian A-1 league championship in season 2006/2007. The assumption was that such indicators, together with a five personality traits might allow for model patterns of team efficiency, as well as for patterns of individual players' efficiency. Bertram and Rao (1974) performed a research using the official NBAteam statistics of the seasons in the period 1968 – 1973, using the set of variables: seven basic and eight transformed variables. The basic variables were: total number of field goals made, total number of free throws made, number of defensive rebounds, number of offensive rebounds, assists, personal fouls, and disqualifications. The transformed variables were: field goal percentage, free throw percentage, number of assisted field goals, number of offensive putbacks, number of free throws after the opponent's personal foul, interaction of the field goal and free throw percentages and interaction of rebounds and assists. The most important variables to distinguish between the participation and non-participation teams were: field goal percentage, free throw percentage, defensive rebounds, offensive rebounds and personal fouls.

Trninić, Dizdar & Lukšić (2002) identified coefficients among the 12 indicators of situation-related efficiency that differentiated between the winning and defeated top quality teams which played in final tournaments of the European club championships from 1992 to 2000. The obtained results suggested that the winning teams showed more of tactical discipline and responsibility in controlling inside positions for defensive rebounds, as well as in controlling play on offense and the ball until the required open shot chance, which considerably reduced game risks and resulted in a lower number of turnovers and in a higher shooting percentage. Such a type of decision-making in play require a high degree of reciprocal help of players on both defense and offense and a higher level of concentration and self-confidence when shooting field goals and free throws. The common denominator of the winning teams was a lower number of imbalanced states in their play (the organized style of play on defense and offense implied) and a higher level of collective outplaying the opponents with the controlled system of play, which enabled entire potential of the victorious teams to be expressed. So, it seems reasonable to connect some personality traits with the situation-related efficiency. Concept of personality explains why one individual differs from all other individuals and it explains his/her behavioral consistency in diverse situations (Knezović et al., 1989). The Big Five Model or the Five-Factor Model (FFM) is substantially descriptive, with the emphasis on the taxonomic aspect, that is, on 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 intellect (Pervin & John, 1997). These five factors represent personality in the highest degree of abstraction, and each of these

dimensions includes a large number of distinct specific characteristics. Extraversion accounts for the amount and intensity of social interaction, activity level, the need for external stimulation and the feature of joy (Trninić, Barančić & Nazor, 2008). Agreeableness assesses quality of interpersonal orientation towards the others along a continuum from pity and compassion to adversary, antagonism in thoughts, emotions and actions. Conscientionusness describes task-oriented and goal-oriented behavior and socially required impulse control. Neuroticism identifies persons who tend to feel negative emotions (anxiety, bitterness, sorrow), who suffer from unrealistic ideas, excessive yearning and urges and have or suffer from maladaptive stress-coping strategies. Intellect (Openness to experience) assesses proactive seeking and appreciation of experience for its own sake, tolerance for the unknown and exploration of the unfamiliar; in other words, it assesses the width, depth and complexity of one's "spiritual world" and life experience (Pervin & John, 1997). Several research studies demonstrated that extraversion and emotional stability from FFM are congruent to extraversion and neuroticism from the Eysenck's model (Mlačić & Knezović, 1997). Ehrhart et al (2008) examined the factor structure equivalence of the 50-item IPIP FFM measure across gender and ethnic groups using multigroup confirmatory factor analysis. Results from a sample of 1,727 college students generally support the invariance of the factor structure across groups, although there was some evidence of differences across gender and ethnic groups for model parameters. The suitability of the Big Five Model for the New Zealand work context was investigated: the five factors showed great similarity with United States findings in terms of their relation to job satisfaction and contextual performance criteria (Guenole & Chernyshenko, 2005). Hence, the goal of this research is to determine and to interpret the relationship between the 12 standard and 7 complex indicators of situation-related efficiency in A-1 Croatian basketball league and big five personality traits. It is assumed that the personality traits have to be significantly positive correlated with standard, as same as with complex indicators of situation-related efficiency in basketball.

Methods

Variables

'*Basketball variables'*, i.e. criteria for quantitative evaluation of players, were chosen on the basis of *partially pondered linear combination* method for evaluation of total quality of the players (Dizdar, 2002). There are 12 standard situation efficacy coefficients, which include data on efficacy of one, two and three point shots (offensive and defensive), won and lost balls, assistances, blocks, personal fouls. On the basis of standard situation efficacy coefficients, seven derived situation efficacy coefficients of basketball players were derived: utilization of two point shots, utilization of three point shots, utilization of free throws, efficacy of two point shots, efficacy of three point shots, efficacy of free throws and total situation efficacy (Dizdar, 2002). The total sample of the games played, from which data on players' and teams' situation efficacy was collected, was sixteen games per team. Therefore, it is a «dual meet» system of competition, in which each team play with all other teams, one game as «hosts» and one game as «guests» respectively. The International Personality Item Pool 50 (IPIP50) is a shorter version of a Goldberg IPIP100 cross-cultural Big-Five questionnaire (Goldberg, 2001, from Goldberg et al., 2005). The current study makes use of the 50-item version consisting of 10 items for each of the Big-Five personality factors: Extraversion (E), Agreeableness (A), Conscientiousness (C), Emotional Stability (ES), and Intellect (I). We administered the IPIP items with a 5-point, Likert-type scale ranging from 1 (very inaccurate) to 5 (very accurate) as in the original instrument (Goldberg, 1999). The IPIP scales have good internal consistency and relate strongly to major dimensions of personality assessed by two leading questionnaires. The IPIP50 items were translated into Croatian by Boris Mlačić (Mlačić, 2002, in Mlačić & Goldberg, 2007) at the Croatian Studies. He found Cronbach's alpha (α) indexes that indicate good reliability: for extraversion, reliability coefficient was α = .88, for Agreeableness α = .81, for Conscientiousness α = .82, for Emotional Stability α =.90 and for the dimension Intellect was α =.78. Gow et al. (2005) examined the structure of the 50-item IPIP in three different adult samples, in each case justifying a 5-factor solution, with only minor discrepancies. Age differences were comparable to previous findings using other inventories. Conscientiousness, Extraversion and Emotional Stability/Neuroticism scales of the IPIP were highly correlated with those of the NEO-FFI (r = 0.69 to −0.83). Agreeableness and Intellect /Openness scales correlated less strongly (r = 0.49 and 0.59). Correlations between IPIP and EPQ-R Extraversion and Emotional Stability/Neuroticism were high, at 0.85 and −0.84. Mlačić & Goldberg (2007) studied a Croatian version of both the 100-item and the 50-item versions of the IPIP Big-Five markers; both self-reports and peer ratings in large Croatian samples of research participants showed clear 5-factor orthogonal structures that were nearly identical to the American structure. Internal consistency reliabilities (Cronbach's alpha) in this research were something lower, but satisfying, ranging from .56 to .73 (Extraversion α = .56, Agreeableness α = .73, Conscientiousness α =.71, Emotional Stability α = .65, Intellect α = .68). In our sample, participants showed 5-factor orthogonal structure, nearly correspondent with the original one.

Participants and procedure

Population from which the purposeful sample of participants was drawn represented by sport success top Croatian senior basketball players, who played in nine men's senior teams of A-1 Croatian Men's Basketball League in 2006/2007: 'Cedevita', 'Svjetlost', 'Borik', 'Kvarner', 'Dubrava', 'Dubrovnik', 'Alkar', 'Šibenik' and 'Osijek'.

The average chronological age was 23. The final sample of participants (74 basketball players) was selected from the initial sample of 107 players. The criteria for selection of a player into the final sample of respondents was the number of minutes in play (minimum ten minutes per game), i.e. the number of games played (minimum eight games played in championship). The players were examined between sixth and eighth round of A-1 league championship (from December 2006 until mid January 2007).

Results

Descriptive statistics data (Table 1) for the standard and derived situation efficacy coefficients in basketball for A-1 Croatian senior league basketball players followed the 'usual' distribution of events on basketball games. Most of the variables follow a normal distribution, except number of unsuccessful free throws, number of assists, and number of offensive rebounds. Descriptive statistics for the dimensions of the IPIP50 for A-1 Croatian senior league basketball players showed that Conscientiousness and Agreeableness are the most pronounced personality characteristics at basketball players.

Data for all the variables are distributed normally. Comparing with the most of samples in other researches (Guenole & Chernyshenko, 2005; Goldberg et al, 2005; Gow et al., 2005), in our research the level of Conscientiousness is something higher level. Possible reason is distinctive: basketball players have to be conscientious, to themselves, as same as to their team.

Table 1. Descriptive statistics for the standard and derived situation efficacy coefficients in basketball for A-1 Croatian senior league basketball players

Variable	Mean	Min	Max	Range	StD	Max D	p
XP2	34,03	2,00	115,00	113,00	22,71	0,12	> ,20
XN2	26,99	4,00	79,00	75,00	15,71	0,08	> ,20
XP3	12,00	0,00	39,00	39,00	9,23	0,11	> ,20
XN3	23,12	0,00	61,00	61,00	16,52	0,12	> ,20
XP1	24,12	1,00	72,00	71,00	16,19	0,14	> ,10
XN1	10,22	0,00	97,00	97,00	12,38	**0,21**	**<,01**
XA	22,51	1,00	105,00	104,00	19,27	**0,18**	**<,05**
XSN	13,88	1,00	48,00	47,00	10,68	**0,17**	**<,05**
XSO	31,20	2,00	87,00	85,00	19,40	0,09	> ,20
XOL	14,45	0,00	34,00	34,00	7,77	0,07	> ,20
XOP	33,23	4,00	64,00	60,00	12,10	0,09	>,20
XIL	21,39	3,00	55,00	52,00	11,59	0,13	> ,10
XK2IS	0,54	0,17	0,72	0,55	0,10	0,08	> ,20
XK3IS	0,31	0,00	0,70	0,70	0,15	0,16	> ,10
XK1IS	0,73	0,40	1,00	0,60	0,13	0,07	> ,20
XK2UC	38,88	0,67	147,77	147,10	29,26	0,14	> ,10
XK3UC	8,84	0,00	34,97	34,97	7,67	0,13	> ,20
XK1UC	17,52	0,50	55,74	55,24	12,12	0,136	> ,20
XDLK	100,51	-1,41	287,68	289,09	64,94	0,08	> ,20

Legend:

Standard coefficients: *XP2=number of successful two point shots; XN2=number of unsuccessful two point shots; XP3=number of successful three point shots; XN3=number of unsuccessful three point shots; XP1=number of successful free throws; XN1= number of unsuccessful free throws; XA=number of assists; XSN=number of offensive rebounds; XSO=number of defensive rebounds; XOL=number of steal balls; XOP=number of personal fouls; XIL=number of lost balls;*

Derived coefficients: *XK1IS= XP1 / (XP1 + XN1) free throw utilization coefficient; XK2IS= XP2 / (XP2 + XN2) two-points utilization coefficient; XK3IS = XP3 / (XP3 + XN3) three points utilization coefficient; XK1UC= = XP1 x XK1IS free throw efficacy coefficient; XK2UC= 2 x XP2 x XK2IS two point shot efficacy coefficient; XK3UC= 3 x XP3 x XK3IS three point shot efficacy coefficient; XDLK= XP1 + 2 x XP2 + 3 x XP3 + XSO + XSN + XA + XOL– 0,5 XN1 – XN2 – XN3 – XIL – XOP total efficiency index*

Table 2. Descriptive statistics for the dimensions of the IPIP50 for A-1 Croatian senior league basketball players

Variable	Mean	Min	Max	Range	StD	max D	p
Extraversion	33,054	22	44	22	4,514	0,093	> ,20
Agreeableness	37,122	23	50	27	4,968	0,092	> ,20
Conscientiousness	37,135	23	50	27	5,362	0,090	> ,20
Emotional Stability	33,757	23	45	22	5,155	0,072	> ,20
Intellect	34,932	25	46	21	4,683	0,092	> ,20

Table 3. Correlations between the dimensions of the IPIP50 for A-1 Croatian senior league basketball players

Variable	Extraversion	Agreeableness	Conscientiousness	Emotional Stability	Intellect
Extraversion	1,00	**0,32***	0,10	**0,26***	0,17
Agreeableness		1,00	**0,29***	0,21	0,12
Conscientiousness			1,00	**0,34***	**0,27***
Emotional Stability				1,00	0,08
Intellect					1,00

Table 4. Canonical correlations between the dimensions of the IPIP50 and groups of and derived situation efficacy coefficients in basketball

Group of variables	Canonical Correlation (R)	Canonical determination (R^2)	χ^2-test	df	p	λ Prime
standard performance coefficients	0,572	0,327	70,688	60	> ,10	0,331
derived performance coefficients - utilization	0,338	0,114	10,781	15	> ,20	0,854
derived performance coefficients - efficiency	0,285	0,081	8,514	15	> ,20	0,883
total efficiency index	0,211	0,044	3,163	5	> ,20	0,956

Derived coefficients*:* utilization *(XK1IS, XK2IS, XK3IS)*
efficiency *(XK1UC, XK2UC, XK3UC), XDLK (total* efficiency *index)*

Pearson inter-correlations between the dimensions of the IPIP50 for A-1 Croatian senior league basketball players (Table 2) show low but statistically significant positive correlations between the dimensions Conscientiousness and Agreeableness, Agreeableness and Extraversion, Extraversion and Emotional Stability, Conscientiousness and Emotional Stability, Conscientiousness and Intellect. Conscientiousness is the highest correlated with other (especially for the one team sport) 'desirable' variables. This fact support previous explanation, connected with a mean value for this dimension, about possible 'special meaning' of this trait for players.

Correlation between Big Five markers and situation-related efficacy coefficients in basketball

Relations between the two groups of variables, dimensions of Big Five personality traits, with indicators of situational efficiency of basketball, were calculated using the canonical correlation analysis, separately for standard, two types of derived indicators of situation-related efficiency, and total efficiency index. In Table 4 is observable that all four canonical roots were not statistically significant. Therefore, there is no significant correlation between the overall set of variables of situational efficiency coefficients and dimensions Big Five personality traits of players in teams that compete in A-1 Croatian men's basketball league. Value of canonical correlation is the highest between standard performance coefficients and dimensions Big Five personality traits, and lowest for the total efficiency index. Because the canonical correlations were not statistically significant, we calculated univariate correlations between all dimensions of Big Five personality traits and indicators of situation-related efficiency. In the cross-correlation matrix we found only 5 from 45 possible statistically significant correlations. Four correlations were positively significant, found between: Agreeableness and number of assists (r=,25; p<,05), number of unsuccessful free throws (r=,25; p<,05), number of balls lost (r=,27; p<,05), and between *C*onscientiousness and three points utilization coefficient (r=,24; p<,05). The only significant negative correlation was found between Intellect and number of offensive rebounds (r= -, 24; p<, 05). About the reasons for these results, we can only speculate.

Discussion and conclusion

The main finding of this research is the fact that there was no statistically significant correlation between the Big Five personality characteristics and situational efficiency coefficients of top basketball players. The expected statistically significant correlation between these two sets of characteristics not found. Although the main finding of this research is lack of statistically significant correlations between. Big Five personality traits and situational efficiency coefficients in basketball, we can assume that a particular relationship between these characteristics in part still exists.

This tendency is reflected in a number of important individual cross-correlations between Big Five dimensions and situational efficiency indicators, which are in principle expected direction. The reasons for the results obtained can be: a real insignificant correlation between the two sets of characteristics (1), a small sample of participants (2), the specificity of the Croatian population of top senior basketball players (3), the specificity of a particular event, i.e., A-1 Croatian league basket ball championships for men in 06/07 season (4), the overall adequacy of the methods of self-assessment as indicators of personality traits (5). The small sample of top players, as well as specificity of the Croatian population of top senior basketball players, can have a direct influence onto reduced possibility of generalization of results. The potentially most important reason for the results obtained came as a consequence of the chosen sample of participants. It is possible that relatively small variability of situation related basketball indicators, as same as small variability for personality traits, could be the result of multiple selectivity of the basketball players' samples. Also, initial decision to carry out the research on only A-1 league players, but not the players of four Croatian most successful teams ('Cibona, 'Zadar', 'Zagreb', 'Split'), the most probably additionally decreased the potential variance in examined (basketball and personality) characteristics. This research represents a potentially valuable attempt to establish a relation between the situational effectiveness in Croatian top basketball and Big Five personality traits. Another value of this research is the fact that it is one of only few studies of psychological characteristics of top Croatian senior basketball players, due to the small number of top players, and because of their difficult accessibility for research purposes.

Main weakness of the research may be partly reflected in the results obtained. It is possible that some non-systematic variable factors influenced the results, which cannot be determined by classical metric indicators. Tests were not conducted under standard conditions, but in the locker room, on the bleachers, next to the playground, or in specific areas, in smaller or larger groups. Potentially the most important shortcoming of the research was a small number of participants examined (but the sample size was prescribed with the criteria for inclusion in the final sample). Results of this research, besides the scientific (taking a purposeful sample of top Croatian basketball players) can have a practical value as well. They can serve as guideline for a more successful selection, but also correction of unwanted deviations in performance of individual players (i.e. for a more efficient work of coaches). The potential reasons for results obtained offer the guidelines for future research. In the future research work the number of respondents could be increased (by testing injured and other absent players). It might be good to include in the sample the players of four Croatian most successful teams, and thus (probably) obtain better variability in researched variables.

An improvement could also be a multiple repetition of the same type of research during more basketball championships. We rejected our main hypothesis. The results showed statistically insignificant canonical correlations between a Big Five personality characteristics and set of situational performance indicators in basketball. Relatively high value of the canonical correlation between two sets of data, indicating the probability that the correlation could be statistically significant, if the number of respondents was slightly higher.

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POVEZANOST VELIKIH PET OSOBINA LIČNOSTI SA SITUACIJSKOM UČINKOVITOŠĆU VRHUNSKIH HRVATSKIH SENIORSKIH KOŠARKAŠA

Sažetak

Utvrđivanje povezanosti pokazatelja situacijske učinkovitosti i psiholoških karakteristika vrhunskih hrvatskih košarkaša, moglo bi dati smjernice za kvalitetniju selekciju vrhunskih senioskih košarkaša, ali i za kvalitetniji trenerski rad. Cilj našeg istraživanja bio je utvrditi povezanost između standardnih i izvedenih parametara situacijske učinkovitosti košarkaša te dimenzija Velikih Pet osobina ličnosti, mjerenih hrvatskom verzijom upitnika IPIP50. Finalni uzorak ispitanika (74 košarkaša) je selekcioniran iz inicijalnog uzorka od 107 košarkaša iz devet muških seniorskih momčadi A-1 Hrvatske muške košarkaške lige iz prvenstva 2006/2007. Rezultati su pokazali da nema statistički značajne povezanosti između Velikih pet osobina ličnosti te skupa parametara situacijske učinkovitosti u košarci. Međutim, relativno visoka vrijednost kanoničke korelacije između dva skupa podataka, ukazuje na vjerojatnost da bi povezanost bila statistički značajna, da je broj ispitanika bio nešto veći.

Ključne riječi: *parametri, standardni, izvedeni, Velikih Pet, kanonička korelacija*

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CORRELATION BETWEEN THE INDICATORS OF SITUATIONAL EFFICIENCY, MORPHOLOGICAL CHARACTERISTICS AND FUNCTIONAL ABILITIES OF FOOTBALL PLAYERS

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Original scientific paper

Abstract

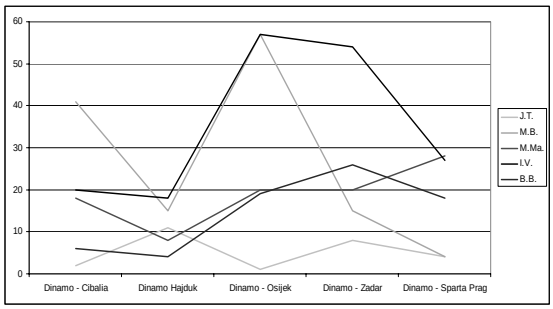
In the 2008/2009 season eleven top football players of Dinamo Zagreb Football Club were assigned to the test group subjected to the system of three morphological measurements, three variables for the estimation of functional abilities on the treadmill and ten indicators of the situational efficiency of football players obtained by the Prozone3 system. The correlation between the variables applied in this research was determined by a correlation analysis; on the other hand, a series of regression analyses determined the correlation between the set of anthropometric indicators and functional abilities as a system of predictor variables in relation to every indicator of the situational efficiency as a criterion variable. The correlation analysis showed a statistically significant correlation between some variables ($p<0,05$). However, the series of regression analyses indicated a lack of statistically significant correlation between the system of predictor variables consisting of anthropometric characteristics and functional abilities and the measured indicators of situational efficiency ($p>0,05$) except for the variable of unsuccessfully passed balls. The conclusion was that the morphological characteristics and functional abilities do not possess any predictive value on the indicators of situational efficiency of the tested group of top football players.

Key Words: *Football, notation analysis, efficiency, indicators, morphological and functional dimensions*

Introduction

Football belongs to the group of complex polistructural kinesiological activities whose main aim is to score more goals than the opposite team, or allow fewer scores by the opposite team. Each of the 11 subjects chosen for the test group possesses unique characteristics and abilities that manifested themselves during the competing activity, and resulted in their unique technical-tactical activities. The perception of football as a kinesiological activity raises a question: How is the success of an individual football player during a competing activity linked with his characteristics and abilities? In order to answer this question, it is first necessary to apply diagnostic procedures and establish the football players' real characteristics and abilities. Then instruments for objective measurement should be applied with the aim of gathering as much relevant information as possible on the actual players' performance during the competing activity. The process of gathering information on a competing activity is called a notation analysis. The data thus obtained are called the indicators of situational efficiency. The majority of team sports face the problem of identifying and intepreting actions and events taking place in the football field. The notation analysis is an effective way of resolving this problem (Hughes and Franks, 2004). It primarily focuses on the movement analysis, technical and tactical estimation and statistical content. This is why the notation analysis is a technique of analysis of various performance aspects via the process of continuous event registration (Hughes and Frank, 2004). Football coaches are able to monitor only the parts of the football field where the core of the game (a ball game) takes place while the information on the game and movements in the other parts of the football field is not known. Every coach's aim is to improve a player or a team by giving them feedback on their performance. Scientific research has proved that human observation and memory are not sufficiently reliable and cannot serve as accurate and objective indicators of an athlete's performance, especially not in a complex sport such as football. It has also been proved that football coaches are less than 45% precise in their analyses of the events taking place within the 45-minute span of a football game (Franks and Miller, 1986). In order to obtain appropriate feedback, instruments of objective measurement are absolutely necessary. They may comprehend various forms of video analyses that rely on data processing during a football game or afterwards, and on biomechanical or computerised notation system. Video recording ensures the most realistic and understandable form of feedback information. In combination with quantitative feedback information it can probably guarantee the best understanding of the information and its use in the modification of later performances (Hughes and Frank, 1997). Hand and computerised notation systems facilitate the collection of information with the aim of analysing the players' movements, assessing the tactical and technical efficiency and providing statistical compilation. The development of computer and video technology has led to certain

changes in the performance analysis and in the use of this analysis in the process of training improvement. The main methods of rendering the mentioned data more objective include the use of video/notation analyses (Hughes and Frank, 1997). Team sports can achieve significant success by using computerised notation analysis, and thus obtained information can be used for instant feedback, database development, identification of positions in the game that need to be improved, assessment and also as a mechanism of selective search via game recording (Franks et al., 1983). So far there has been a number of scientific studies in the field of football where the authors engaged in the analysis of characteristics and abilities of football players (Wisloff et al., 1998; Rienzi et al., 2000; Reilly et al., 2000; Casajus, 2001). There have also been studies where the authors focused on the analysis of situational efficiency of football players (Luhtanen, 1993; Tiryaki et al., 1997; Pearce and Hughs, 2001; Luhtanen et al., 2002). However, having studied the available literature, we have not been able to idenfity a single study of the correlation between, on the one hand, the indicators of situational efficiency measured by a computerised notation system and, on the other, morphological characteristics and functional abilities of players.



Graph 1. Overall number of passed balls in five games

Problem and Aim

This study tried to resolve the problem of correlation between, on the one hand, the indicators of situational efficiency and on the other, the morphological characteristics and functional abilities of the top football players. Thus, the aim of the study was to establish the correlation between all the measured variables and to establish the correlation between, on the one hand, the morphological characteristics and functional abilities as a set of predictive variables and, on the other, every variable of the situational efficiency of football players.

Methods

The test group consisted of 11 football players of Dinamo Zagreb Football Club playing in five football matches in the 2008/2009 season of the Croatian First League. The data was gathered at two locations. The first set of data was gathered by the Sports Diagnostic Centre of the Faculty of Kinesiology, University of Zagreb, during the pre-contest period.

Firstly, the footballers' basic morphological characteristics were measured: height (cm), weight (kg) and subcutaneous fat tissue (%). Then they were subjected to a test with the aim to assess their energy capacity on the treadmill. The test measured the following variables: average maximum oxygen intake (mL $kg^{-1}min^{-1}$), maximum heart rate frequency (b min^{-1}) and maximum running speed (km h^{-1}). The second part of the data collection refers to the collection of the indicators of situational efficiency, which was carried out by means of Prozone3, an up-to-date and most objective instrument of measurement of this kind. Prozone3 is an interactive analysis system developed in accordance with the demands of top football coaches. The precondition for its use is the installment of at least 8 video cameras inside the football stadium, and in this research 9 video cameras were used. The video recording is then analysed by means of Prozone3 software, most frequently following a football match.

In general, Prozone3 provides a rerun of the whole 90-minute match. The data stored in this software analyse the movements, actions and interactions of every player in both teams. Numerous studies have proved independently the efficiency of this system in providing accurate and reliable information (Di Salvo et al., 2006). Ten indicators of situational efficiency were used in this research (Table 3). The gathered data were processed by SPSS v13.0, a statistical software product for data management and analysis. The reliability of the indicators of situational efficiency were determined with Cronbach's α coefficient and interclass correlation coefficient. Then descriptive parameters and correlation coefficients were calculated, which was followed by the use of regression analyses with the aim of determining the correlation between, on the one hand, anthropometric and functional characteristics and, on the other, the indicators of situational efficiency. Every variable of these indicators was set as a criterion variable while the variables of anthropometric and functional characteristics represented a set of predictive variables.

Results

Statistically significant correlations ($p<0.05$) have been established between the following variables: overall number of passed balls and successfully passed balls ($r=0,99$), overall number of passed balls and unsuccessfully passed balls ($r=0,79$), unsuccessfully and successfully passed balls ($r=0,71$), average sprint length and maximum speed ($r=0,83$), number of sprint runs and unsuccessfully passed balls ($r=0,63$), total distance covered during the second half and number of sprint runs ($r=0,62$), total distance covered in sprint run and unsuccessfully passed balls ($r=0,67$), total distance covered in sprint run and number of sprint runs ($r=0,91$), height and weight ($r=0,71$), average maxium oxygen intake and total distance covered in sprint run ($r=0,61$), maximum running speed and number of sprint runs ($r=0,76$).

Table 1. Anthropometric and functional characteristics

	Age (years)	Height (cm)	Weight (kg)	Sub-cutaneous fat tissue (%)	Average maximum oxygen intake (mL $kg^{-1}min^{-1}$)	Maximum heart rate frequency (b min^{-1})	Maximum running speed (km h^{-1})
J.T.	20,8	185,9	78,5	5,82	57,7	204	19
M.B.	19,3	184,6	76,5	4,99	64,7	189	19
M.Ma.	22,1	188,0	78,7	6,26	62,6	197	19,5
I.V.	24,7	187,5	82,7	5,1	62,6	202	20,5
B.B.	29,7	178,6	81,2	9,59	61,3	194	18,5
M.Mi.	28,4	174,6	67,8	5,17	68	204	20
I.B.	30,1	188,9	84,5	6,96	60,2	185	18
M.Ch.	25,3	181,6	78,6	6,71	54,1	181	18,5
C.Sa.	27,3	187,8	84,8	7,63	53,2	206	18,5
S.E.	27,3	176,4	77,8	7,19	55	193	17
A.T.	25,1	186,2	81	7,5	57,5	204	21

Table 2. Descriptive statistics of the indicators of situational efficiency and anthropometric and functional characteristics

	M ± SD	Standard Error AS	Min	Max	Range	Coefficient of variation	Cronbach's α	Interclass Correlation coefficient
Maximum running time (km h^{-1})	9,11 ± 0,18	0,06	8,80	9,40	0,60	1,97%	0,71	0,71
Passed balls	26,17 ± 15,74	4,74	5,20	55,00	49,80	60,14%	0,91	0,91
Successfully passed balls	22,21 ± 14,07	4,24	3,60	47,67	44,07	63,35%	0,92	0,92
Unsuccessfully passed balls	3,78 ± 2,37	0,71	1,00	8,50	7,50	62,70%	0,87	0,87
Average sprint speed	2,07 ± 0,18	0,05	1,80	2,30	0,50	8,70%	0,95	0,95
Average sprint length (m)	7,01 ± 1,87	0,56	5,10	11,90	6,80	26,68%	0,98	0,98
Number of sprint runs	32,27 ± 11,14	3,36	11,00	51,50	40,50	34,52%	0,81	0,81
Covered distance in the first half (m)	4774,45 ± 2406,77	725,67	0,00	6341,00	6341,00	50,40%	1,00	1,00
Covered distance in the second half (m)	4571,1 ± 868,68	261,92	3223,33	5765,75	2542,42	19,00%	0,79	0,79
Covered sprint distance (m)	244,87 ± 109,47	33,01	130,50	479,28	348,78	44,70%	0,90	0,90
Age (god.)	25,46 ± 3,56	1,07	19,30	30,10	10,80			
Height (cm)	183,64 ± 5,05	1,52	174,60	188,90	14,30			
Weight (kg)	79,28 ± 4,68	1,41	67,80	84,80	17,00			
Subcutaneous fat tissue (%)	6,63 ± 1,37	0,41	4,99	9,59	4,60			
Average maximum oxygen intake (mL $kg^{-1}min^{-1}$)	59,72 ± 4,67	1,41	53,20	68,00	14,80			
Maximum heart rate frequency (b min^{-1})	196,27 ± 8,58	2,59	181,00	206,00	25,00			
Maximum running speed (km h^{-1})	19,05 ± 1,15	0,35	17,00	21,00	4,00			

Table 3. Indicators of situational efficiency

	Maximum	Overall	Successfully	Unsuccessfully	Average	Average	Number of	Covered	Covered	Covered
J.T.	9,1	5,2	3,6	1,6	2,16	6,84	29,8	6310	4103,5	232,2
M.B.	9	26,4	23	3,4	2,2	6,06	23,4	6214,33	3958,25	140,08
M.Ma.	9,18	18,8	12,6	4,2	1,8	7,8	44,8	5002,2	4056,6	396,12
I.V.	9,16	35,2	31,6	3,6	2,04	7,04	39,2	5845	5346,8	302,8
B.B.	9	11,75	10,5	1,25	2,025	6,1	24,25	6178,5	5217	157,02
M.Mi.	9,4	42,5	34	8,5	2,1	8,275	51,5	6032,5	5765,75	479,27
I.B.	8,97	55	47,67	7,33	1,8	6,13	30,33	5024	5092,33	242,37
M.Ch.	8,8	27	22,33	4,67	2,27	5,1	27,67	6341	3223,33	177,67
C.Sa.	9	41	38	3	1,85	5,55	35	5571,5	5013,5	198,7
S.E.	9,4	13	12	1	2,2	11,9	11	0	3316	130,5
A.T.	9,2	12	9	3	2,3	6,2	38	0	5189	236,8

Table 4. Results of regression analyses

Criterion variable	ρ^2	$F_{(7,3)}$	P
Maximum running speed (km h^{-1})	0,63	0,73	0,67
Overal number of passed balls	0,84	2,24	0,27
Successfully passed balls	0,81	1,80	0,34
Unsuccessfully passed balls	0,98	24,95	0,01
Average sprint speed	0,83	2,07	0,30
Average sprint length (m)	0,51	0,45	0,83
Number of sprint runs	0,90	3,78	0,15
Covered distance in the first half (m)	0,23	0,13	0,99
Covered distance in the second half (m)	0,94	6,38	0,08
Covered sprint distance (m)	0,84	2,20	0,28

Discussion and Conclusion

The obtained values of the morphological characteristics are in accordance with the research carried out on top football players in some European leagues (Czech, Slovakian, Spanish and Swedish), as well as the average maximum oxygen intake that is insignificantly lower than in the mentioned research (Bunc and Pssota, 2001; Casajus, 2001; Ekblom, 1986; Heller et al., 1992). All the variables of the situational efficiency have high reliability coefficients except for the variable of the maximum running speed which has a lower reliability coefficient (Cr α = 0,71), but is still satisfactory. This means that all the mentioned variables represent accurate indicators of the situational efficiency of the football players. The coefficient of variation, as an indicator of the dispersion of results, is significantly low for the variables of the maximum running speed (1,97%) and average sprint speed (8,7%). This is due to the high quality of the selected test group.

The other indicators point out greater dispersion, which is due to the players' various positions in the match, their technical-tactical tasks and their different levels of quality. The high correlation between the variable of the overal number of passed balls and the variable of successfully passed balls (r=0,99) on the one hand, and the variable of unsuccessfully passed balls on the other (r=0,79) results from presenting the data in absolute values. It is logical to assume that, on average, players with more passed balls also have more successfully and unsuccessfully passed balls. Trainers would especially profit if the future results for successfully and unsuccessfully passed balls per player were expressed in percentage and in relation to the total number of passed balls per game. It is interesting to notice that there is a statistically significant correlation between the variables of unsuccessfully passed balls and number of sprint runs (r=0,63) and the variable of covered distance in sprint run (r=0,67). Certain studies (Rampinini et al., 2008; Rampinini et al., 2009) have proved that this is caused by the influence of tiredness on technical performance and accuracy in ball passing during a football match. The correlation of the variable of the number of sprint runs and the variable of distance covered in the second half (r=0,62) and the variable of the covered distance in sprint run (r=0,94) is understandable because the players with more covered distance in general, especially with more covered distance in sprint run, do more sprint runs during a football match. As a football player needs to cover a certain distance in order to reach high running speed, the correlation between the variables of average sprint run and maximum speed (r=0,83) is logical. The correlation of the variable of the number of sprint runs and the variable of maximum running speed (r=0,76) as well as the correlation of the variable of average maximum oxygen intake and covered distance in sprint run (r=0,61) indicate that players with better functional abilities are capable of doing more sprint runs. In other words, they can play in a football match with more intensity and have a shorter period of recovery after such an activity, which only supports the recent research that indicates that the maximum oxygen intake (VO2max) has a positive correlation with the covered distance in a football match (Bangsbo, 1994; Smaros, 1980). A series of regression analyses provided interesting results and showed that with such top football players the set of predictive variables consisting of several morphological characteristics and three variables estimating functional abilities (average maximum oxygen intake, maximum heart rate frequency, maximum running speed on the treadmill) are not a statistically significant predictive factor for the variable of the football players' situational efficiency measured by Prozone3 system.

The variable of unsuccessfully passed balls is an exception, which further proves the fact that the set of morphological characteristics and the measurement of functional abilities do not serve as indicators or predictors of high efficiency of top football players during a football match. A correlation between the sprint run number and maximum running speed was also established, as well as that betweeen the covered distance in sprint run during a game and maximum oxygen intake. Thus, we can conclude that football players with better functional abilities cover a greater distance in sprint runs (Bangsbo, 1994; Smaros, 1980). It is obvious that the mentioned set of morphological characteristics and functional abilities does not represent a predictor of real situational efficiency of top football players. The real situational efficiency is determined by a number of other abilities, characteristics and technical-tactical knowhow.

Of course, a high level of functional abilities is essential for success in a football match, but many other characteristics also define the situational efficiency of top football players in modern football. This proves the complexity of success in football and the necessity of use of such notation analyses in the measurement of real and concrete indicators of situational efficiency in football players. A greater variety of functional and motoric variables should be applied in future research and their correlation with various indicators of situational efficiency of football players should be analysed as well.

Prozone is primarily a tool that provides the detection of the real situational efficiency of an invidual player and the team in concrete situations. This is why it represents an excellent means of determining the concrete behaviour in a game. It is also an excellent additional test of morphological, motoric and functional abilities of football players helping to identify the good and bad sides of football training and improvements of sports performance that have to be carried out via the training process.

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POVEZANOST PARAMETARA SITUACIJSKE EFIKASNOSTI S MORFOLOŠKIM KARAKTERISTIKAMA I FUNKCIONALNIM SPOSOBNOSTIMA NOGOMETAŠA

Sažetak

Na uzorku od jedanaest vrhunskih nogometaša Nogometnog kluba Dinamo u sezoni 2008/2009. primijenjen je sustav od tri morfološke mjere, tri varijable za procjenu funkcionalnih sposobnosti mjerenih na pokretnoj traci i deset pokazatelja situacijske efikasnosti nogometaša dobivenih sustavom Prozone3. Relacije između pojedinih varijabli primijenjenih u ovom istraživanju utvrđene su korelacijskom analizom, dok je povezanost skupa antropometrijskih pokazatelja i funkcionalnih sposobnosti kao sustava prediktorskih varijabli u odnosu na svaki parametar situacijske efikasnosti kao kriterijske varijable utvrđena serijom regresijskih analiza. Rezultati korelacijske analize su kod nekih varijabli pokazali međusobnu statistički značajnu povezanost ($p<0,05$). Serija regresijskih analiza je pokazala kako sustav prediktorskih varijabli koji se sastojao od antropometrijskih karakteristika i funkcionalnih sposobnosti nema statistički značajnu povezanost ($p>0,05$) s mjerenim pokazateljima situacijske efikasnosti, osim s varijablom neuspješna dodavanja. Zaključeno je da skup morfoloških karakteristika i funkcionalnih sposobnosti nema prediktivnu vrijednost na pokazatelje situacijske efikasnosti mjerenog uzorka vrhunskih nogometaša.

Ključne riječi: *nogomet, notacijska analiza, efikasnost, morfološke i funkcionalne dimenzije*

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THE INFLUENCE OF SITUATION EFFICIENCY ON THE RESULT OF A HANDBALL MATCH

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Original scientific paper

Abstract

The main aim of this paper is to determine and explain the differences between the winning and the defeated teams based on the situation indicators of the attack finalisation in top senior handball. We have analysed 101 matches played during the World Championship for men held in Croatia in 2009. We analysed the differences (ANOVA) on the total sample of matches on certain levels of the competition. In this purpose we applied three groups of variables of shooting on goal: the number of shots on goal, the number of scored goals and the percentage of realisation in the position and the transition attack. The results of the research show that influence of situation variables on the final result of a handball match is lower in the opponents of equal quality, and higher in broad range of quality. The winning teams are more efficient in all the parameters of final actions of the attack. The number of goals from the pivot position significantly contributes to the victory in quality teams. The result of a handball match between two quality teams is determined by shooting efficiency from the outer positions which suggests how important the outer players are in creating results in top handball. The limits of this research lie in the fact that situation-related parameters of final actions describe only partial, not complete efficiency of players and teams in the handball game. For future researches, it is therefore necessary to create a combined model of evaluation of complete efficiency in the players' and teams' playing by linking objectively collected data on the situation efficiency of handball players.

Key words*: competitive result, handball, situation efficiency variables, finalisation of attack*

Introduction

Due to a large number of players, complexed aims within game roles and different modalities of cooperation and confrontation, it is not simple to analyse technical-tactical activities of players and the whole team in handball. Javier (1992) states it is important to, in the context of the analysis of sport games, take into account all the parameters which define the development of action in the game: the rules of the game, technique, tactics, space, time and communication. At the same time, he is indicating that in order to understand the game, a holistic approach is essential since it comprises complete efficiency in the game, but also separate observance of parts of the game which comprises partial efficiency in the game.

At the same time, partial efficiency in the game comprises only those factors which can be noted down statistically in the final actions of players in a match (situation efficiency indicators), also known as the playing efficiency or situation efficiency of players (Jošt, Dežman, Pustovrh, 1992; Swalgin, 1998; Erčulj, 1998; Dizdar, Trninić, Milanović, 1997; Trninić, Dizdar, Jaklinović-Fressl, 1999). Complete efficiency in the game comprises all the important elements of the actual quality of a player in a match or a certain competition, evaluated by experts through a certain criteria system. The basis for the research of complete efficiency in the game was provided by a group of researchers (Trninić, 1996; Trninić, Perica, Dizdar, 1999; Trninić, Dizdar, 2000; Trninić, Dizdar, Dežman, 2000; Dežman, Trninić, Dizdar, 2001; Trninić, Dizdar, Dežman, 2002).

In contemporary sport, the structure of parameters of the competitive activity is basis for comparative analysis of the athletes' and teams' quality, which is particularly important for rational planning and programming of the process of sport preparation. It is therefore necessary to precisely model the profile of the individual structure of situation efficiency indicators in a certain player and/or the whole team. In addition to this, expert trainers and scientists-practitioners must be able to evaluate situation efficiency indicators and the complete actual quality of a player. Trninić (2006) states that situation-related efficiency is an indicator of partial efficiency in the game, and that it is determined by individual and team level of sport form, by coordination of the team and by the level of integral preparation of players and the whole team. Situation efficiency is a partial indicator of the actual quality of a player and playing. It is determined by individual and team level of sport form, by coordination of the team and by the level of integral preparation of a player and the whole team. Situation efficiency is not only the function of a situation and the actual quality of a player, but of the tactics of the opposed teams and of the judges' decisions and of the influence of the audience and of the functional relation within the team (the quality of cooperation), and of the level of believing in the system of playing and the way of training and the put in effort in the playing of both teams. Thus, the notion of situation efficiency of a player is broad and difficult to be defined precisely, passing, at the same time, the time test in the profession and sport science.

In order to understand the situation efficiency, it would be best to observe the scheme of the factors determining it. It is evident that situation efficiency of players and team is the function of a large number of variables which influence their efficiency. Handball, like other team sports with a ball, demands for analyses which would evaluate competitive success based on situation efficiency variables within certain phases of the game course, determined by the successfulness level of achieving the aim that every player should accomplish regarding his position and role in the team within the playing tactics model. Previous researches on situation efficiency in handball studied efficiency with regard to playing positions (Gruić et al. 2006, Ohnjec et al. 2008), shooting zones (Pokrajac 2008, Rogulj, 2000) and efficiency with regard to different ways of shooting (Delija 1994, Vuleta et al. 2003). Other studies have been conducted on differences between frequencies and shooting efficiency with relation to a team's efficiency (Apitzs et al. 1997, Taborsky 2008), the influence of tactics elements and the influence of the finalisation of attack variables on the final score of a game (Srhoj et al. 2001, Rogulj et al. 2004, Rogulj et al. 2009).

Problem and the aim

According to previous knowledge, teams greatly differ on the level of performing technical-tactical playing elements, particularly when the criterion is competitive successfulness. It is assumed that situation efficiency variables greatly determine the result of a match. In determining the final result of a handball match, the highest prognostic quality lies in the variables of the final attack actions. The mentioned variables are primarily manifested through technical-tactical activities which include shots on goal. Undoubtedly the efficiency in shooting on goal influences the development of the result and the final result of the match (Rogulj 2001). The purpose of this research is to determine and explain the differences between the winning and the defeated teams based on the situation efficiency indicators of the final attack actions in top handball based on the analysis of the World Handball Championship for Men held in Croatia in 2009.

Methods

Entities sample

Entities sample of this research are all the matches of the World Handball Championship in 2009. Every match generated 2 entities, the total of 202 (101 matches) whereby the teams with higher ranking, due to the competition system, played one match more (9) than those with worse ranking (8). The data used for the analyses in the study were taken over from the statistical forms of final actions which the International Handball Federation (IHF) announced on its website after the championship had finished. All 24 teams participated in the championship and were divided in 4 groups of 6 and played mutually (preliminary round). After this part of competition, the best three teams from every group played with the best three teams from the other group following the principle A-C and B-D (main round), while the three worst teams played against the worst from the other group (president's cup). After this, the best teams played for the medals, i.e. played-off for ranking from the fifth to the twelfth position (finals). Due to the aim of the research, we eliminated matches with tied scores (3 matches, 6 entities). The first analysis referred to all the matches in the championship (202 entities), while the remaining analyses comprised the following levels of the competition: Preliminary round (116 entities), President's cup (36 entities) and the Main round and Finals (50 entities).

The sample of variables

The total sample of manifested variables consists of three groups: the frequency of shooting on goal, efficient shots (goals) and the percentage of realisation (the relation between the frequency and the scored goals). Within every group there are five variables (the total of 15 variables): shots from the 6m line (6m/S), shots from the wing position (Wing/S), shots from the outer positions outside the 9m line (9m/S), shots from 7m (7m/S), shots from the attack transition (FB/S), goals from 6m line (6m/g), goals from the wing positions (Wing/G), goals from the outer positions outside 9m line (9m/G), goals from 7m (7m/G), goals from attack transition (FB/G), efficiency from 6m distance (6m/%), efficiency from wing positions (Wing/%), efficiency from the outer positions outside 9m line (9m/%), efficiency from 7m (7m/%) and shooting efficiency after attack transition (FB/%).

Data processing methods

Based on the data, we determined basic descriptive statistical parameters: arithmetic means (AS), standard deviations (SD) and Kolmogorov-Smirnova test. To analyse differences between the groups we used one-way variance analysis. The distribution of results in some variables was not normal, thus we used non-parametrical Kurskal-Wallis ANOVA method for their processing. It is important to mention that the result matrix was composed in a way that the analyses did not include those entities which had no attempts in certain variables (the absence of variables does not make the entity inefficient). All the analyses were conducted by Statistica ver. 7 software packet. The results are presented in the tables and due to better comprehension of certain relations, one graph has been displayed as well.

Results

Table 1 displays all descriptive analyses results obtained from all the matches together within certain segments of the competition. Taking into account that 11 variables of the total sample and 8 variables of the matches in the first round do not show the normal distribution of results, it is evident they must be processed by non-parametrical statistical methods.

Table 1. Descriptive statistics for all the matches, the first round of the competition and playing for positions 1-24

groups	all matches		preliminary round		presidents cup		main round / finals	
VAR	N	AS±SD	N	AS±SD	N	AS±SD	N	AS±SD
6m/S	20	8,77±3,73*	12	8,98±3,71*	36	9,78±4,26	50	7,36±2,93
Wing/S	20	7,11±3,59*	11	7,25±3,53	36	8,33±4,6	50	5,86±2,27
9m/S	20	21,79±7,25	12	21,13±7,02	36	20,67±7,04	50	24,6±7,44
7m/S	19	3,81±1,89*	11	3,94±1,95*	32	3,66±1,94	47	3,64±1,67
FB/S	19	6,81±3,99*	11	6,69±4,45*	35	6,89±2,86	50	6,84±3,54
6m/G	20	5,76±2,81*	12	5,89±2,82*	36	6,56±2,92	50	4,76±2,42
Wing/G	20	3,98±2,6*	11	4,03±2,75*	36	4,56±2,79*	50	3,36±1,87
9m/G	20	8,57±3,57	12	8,33±3,69	36	7,86±3,45	50	9,82±3,04
7m/G	19	2,78±1,64*	11	2,85±1,64*	32	2,44±1,56	47	2,77±1,63*
FB/G	19	5,09±3,4*	11	4,97±3,84*	35	5,29±2,5	50	5,08±2,78
6m/%	20	66,16±18,26	12	66,52±16,97	36	68,11±17,7	50	64,22±21,54
Wing/%	20	54,15±23,46	11	51,41±23,22	36	57,31±20,5	50	57,62±25,66
9m/%	20	40,63±14,17	12	40,93±15,48	36	39,06±14,0	50	41,06±10,24
7m/%	19	74,03±25,17	11	73,82±23,55	32	68,94±30,4	47	76,23±25,67*
FB/%	19	73,91±21,02	11	74,34±22,17	35	74,77±21,8	50	73,32±17,67

*KS p<0,05

Table 2. Univariant variance analyses on the total sample of the matches and the matches in groups

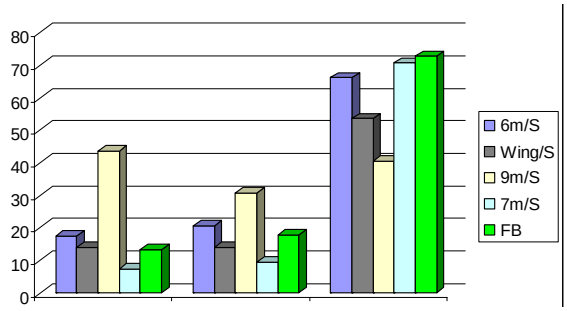
groups	all matches			preliminary round		
VAR	winning	defeat	F / H	winning	defeat	F / H
	AS±SD	AS±SD		AS±SD	AS±SD	
6m/S	3,84 ± 0,39	3,56 ± 0,37	3,92 **	9,44 ± 3,94	8,67 ± 3,63	1,11
Wing/S	7,94 ± 4,00	6,55 ± 3,04	5,67 **	8,35 ± 3,89	6,27 ± 2,92	9,83 *
9m/S	19,3 ± 7,34	23,7 ± 6,70	18,42 *	18,1 ± 7,03	23,5 ± 6,06	17,88 *
7m/S	3,73 ± 1,88	3,91 ± 1,94	0,32	3,72 ± 1,95	4,19 ± 2,02	1,50
FB/S	8,28 ± 4,65	5,36 ± 2,69	23,79 *	8,77 ± 5,21	4,75 ± 2,35	19,98 *
6m/G	6,48 ± 2,85	4,97 ± 2,62	14,30 *	6,53 ± 2,95	5,35 ± 2,77	3,92 **
Wing/G	4,90 ± 2,92	3,20 ± 1,97	17,55 *	5,25 ± 3,05	2,90 ± 1,83	23,02 *
9m/G	8,95 ± 3,67	8,02 ± 3,29	3,31	8,79 ± 3,83	7,69 ± 3,49	2,43
7m/G	2,93 ± 1,71	2,66 ± 1,58	1,16	3,04 ± 1,70	2,79 ± 1,65	0,83
FB/G	6,50 ± 3,95	3,67 ± 2,09	31,08 *	6,81 ± 4,56	3,19 ± 1,77	23,36 *
6m/%	71,01 ± 14,72	60,90 ± 20,29	15,38 *	71,46 ± 13,49	60,60 ± 18,45	12,45 *
Wing/%	59,68 ± 22,32	48,02 ± 23,08	13,88 *	58,79 ± 21,76	44,73 ± 22,92	10,79 *
9m/%	47,68 ± 13,51	33,96 ± 11,09	57,61*	49,82 ± 14,04	32,42 ± 11,90	38,86 *
7m/%	79,59 ± 22,64	69,01 ± 26,76	8,60 *	82,63 ± 18,73	67,13 ± 25,30	12,44 *
FB/%	77,89 ± 17,85	69,70 ± 23,29	5,13 **	77,18 ± 18,16	70,31 ± 26,09	2,58

(* p < 0,01, ** p < 0,05)

Table 3. Univariant variance analyses of the matches for positions 13-24 and 1-12

groups	presidents cup			main round / finals		
	winning	defeat	F / H	winning	defeat	F / H
VAR	AS±SD	AS±SD		AS±SD	AS±SD	
6m/S	10,76 ± 4,13	8,40 ± 3,85	2,78	8,05 ± 2,97	6,72 ± 2,92	2,37
Wing/S	9,29 ± 5,25	8,20 ± 3,95	0,43	5,82 ± 2,04	6,16 ± 2,41	0,27
9m/S	18,00 ± 5,98	22,00 ± 7,81	2,68	23,4 ± 7,90	25,2 ± 7,22	0,72
7m/S	3,82 ± 1,98	3,47 ± 1,96	0,26	3,68 ± 1,67	3,60 ± 1,71	0,03
FB/S	7,71 ± 3,20	5,93 ± 2,31	3,15	7,45 ± 4,01	6,28 ± 3,27	1,22
6m/G	7,65 ± 2,74	5,33 ± 2,38	6,42 **	5,45 ± 2,34	3,96 ± 2,24	4,98 **
Wing/G	5,29 ± 3,24	4,27 ± 2,31	1,04	3,68 ± 1,91	3,16 ± 1,91	0,87
9m/G	7,53 ± 3,20	7,13 ± 3,16	0,12	10,45 ± 3,17	9,24 ± 2,65	2,04
7m/G	2,59 ± 1,54	2,27 ± 1,62	0,33	2,91 ± 1,87	2,64 ± 1,41	0,31
FB/G	6,29 ± 2,71	4,07 ± 1,94	6,96 *	5,86 ± 2,98	4,44 ± 2,53	3,13
6m/%	72,88 ± 15,56	65,60 ± 20,01	1,34	68,41 ± 17,33	58,72 ± 24,19	2,43
Wing/%	59,76 ± 19,84	53,80 ± 20,31	0,70	61,91 ± 26,15	51,40 ± 24,63	2,01
9m/%	42,76 ± 15,68	33,33 ± 10,76	3,83	45,91 ± 8,81	37,52 ± 8,94	10,45 *
7m/%	72,35 ± 23,77	65,07 ± 37,16	0,45	77,32 ± 29,66	75,28 ± 22,16	0,07
FB/%	80,94 ± 17,42	65,87 ± 25,13	3,97	77,36 ± 17,93	70,72 ± 15,23	1,89

(* p < 0,01, ** p < 0,05)



Graph 1. The percentage of certain parameters in complete efficiency
0-80 = relation

This is assumed to be the consequence of high variability in quality among the teams where more quality teams created a large number of attempts and goals in the matches with significantly worse opponents in most of the observed situation efficiency variables. Further on, normal distribution is present in most of the situation efficiency variables in the final round of the competition in which the national teams were divided according to the success in the first round. All together, only the results of three variables showed irregular distribution. The evenness of the teams' quality most probably influenced the normality of result distribution. On the other hand, graph 1 displays the obtained results in the relations of certain situation efficiency parameters with the total value of the observed group of parameters (the number of shots on goal, the number of scored goals and efficiency). Observing manifest variables, it is evident efficiency does not completely coincide with shooting frequency and the number of scored goals. The total number of shots mostly refers to the shots from the outer positions (43,53%) which is rather evident in the number of scored goals (30,7%), but these shots, however, had the lowest efficiency. Tables 2 and 3 display the obtained analyses results of the differences between the winning and the defeated teams of certain segments of the competition and the total sample. In the first round of competition as well as in the total number of matches, the winning teams had more attempts from the pivot position, the wing position and in the counterattack. The defeated teams had significantly more shots from the outer playing positions, while the teams do not statistically differ in the number of 7m penalty shots. The second round of the competition does not bring any significant differences in any of the manifest variables, i.e. the teams do not have any statistically significant differences in the number of shots on goal which proves their evenness in the playing quality. In the first round of the competition and in the rest of the championship, the winning teams scored significantly more goals from the positions of pivot, wing and in the counterattack. Therefore, it is important to emphasize that there are no statistically significant differences in the number of goals from the outer positions and from 7m penalty shots. There are differences in the second round of the competition only in the number of goals from the pivot position. In "President's Cup" group, the winning teams achieve remarkably more goals from the counterattack. The first round of the competition and the total sample of entities show similar results with regard to the efficiency of the observed manifest variables. In all the mentioned variables there is a statistically significant difference between the winning and the defeated teams. The only exception is the counterattack efficiency which is not different in the two entities group in the analysis of the first round of the competition. It is important to emphasize that shooting efficiency variable from the outer position is different in the winning and the defeated teams in the second round of the competition.

Discussion and conclusion

Observing the obtained results of the conducted analyses, we can detect several features which show the results are nearly identical when comparing the first round of the competition and the total sample and when comparing two levels of the competition in the second round ("President's Cup" and "Main Round and Finals"). The probable reason for these results is the difference in the quality of the teams which participated in the competition. Namely, in the first round of the competition the teams were divided into groups of teams with different qualities which is evident from the results of the matches in the first round. A larger difference in quality is manifested in the differences in the situation efficiency variables which is determined by statistical analyses as well. The identical obtained situation even with the total sample may be interpreted when we notice that the number of the matches in the first round (58 matches – 116 entities) represents more than a half of the total sample (101 matches – 202 entities) which means there is a larger number of the matches with bigger differences in the actual quality of the teams in the total sample. The second round of the competition isolated quality teams from the less quality ones and thus both groups continued the competition in their qualitative classes; the worse ones in the "President's Cup" and the better ones in the "Main Round and Finals". This separation of quality resulted in the even matches which ended with a small goal average. At the same time it is important to emphasize that the minimal number of manifest variables was significantly statistically different. In the total sample the winning teams are significantly different from the defeated ones in all the parameters of situation efficiency. Variables Wing, 6m and FB present final actions in which the shooting is performed from a closer distance to the goal than when shooting from 9m distance. It is assumed the distance in shooting in each of these is in relation to the level of scoring probability. Thus the winning teams were shooting from these positions more times, scored more goals and due to this, had higher situation efficiency from the mentioned positions. This is not the case in the 9m shooting where the defeated teams shot more and scored less. In terms of handball, it suggests the non-selection of shooting which is a characteristic of the players' reaction in the mentioned teams,

manifested in a low shooting percentage from the outer positions. According to this, it caused higher situation efficiency of the winning teams whose actions more frequently ended in selective shooting which enabled higher shooting efficiency and more efficient defence transition. Both groups had an approximately equal number of 7m penalty shots (a few more in the defeated teams) and equally scored, but the efficiency was significantly higher in the winning teams stating the individual quality of the players was crucial in the efficiency of this element. In the first round of the competition there are differences in all the manifest variables in the position attack. The winning teams had significantly more attempts and goals in the counterattack, and at the same time high efficiency as well, which did not create any differences in efficiency since the defeated teams, although having less shots, also had high efficiency in shooting. It may be concluded that in the first round all the teams had high counterattack shooting efficiency which is the consequence of taking the easiest position for scoring. Though with no difference in the number of attempts, a significantly larger number of goals from the pivot position contributed to significantly higher efficiency of the winning teams. Lower shooting efficiency from the outer positions in the defeated teams is the consequence of the significantly larger number of attempts which did not create the difference in the number of scored goals. The winning teams were more efficient in scoring 7m penalty shots regardless of the fact there was no difference in the number of attempts and scores. In "President's Cup" there were no significant differences in any of the situation efficiency variables. Although the winning teams scored more goals in counterattacks and in the pivot position, this did not create any statistically significant differences in the efficiency of the mentioned variables. In the main part of the second round of the competition where the most quality teams of the championship were ranked, only one variable showed statistically significant differences between victory and defeat, and this was shooting efficiency from the outer position. This variable was found significant regardless of the fact that both groups had statistically insignificant different number of attempts and scores. By analysing the obtained results we may taxatively draw the following conclusions: the more equal the teams are, winning depends on a smaller number of situation efficiency variables; the bigger the differences in the quality of the teams are, the bigger is the difference in the parameters of situation efficiency of the final actions in attack in the winning and defeated teams; when the teams are classified according to their quality, statistically significant differences are minimal, but present in all the situation efficiency variables in favour of the winning teams; the percentage of realisation in certain situation efficiency variables is influenced by the number of shots on goal and the number of scored goals whereby this influence can be positive and negative; the bigger the variability in the actual quality among the teams is (the first round of the competition and the total sample), the more emphasized is the efficiency of the final actions in attacks of the winning teams the smaller the differences in the actual quality among the teams are (the second round of the competition), the more expressed is the shooting efficiency from the outer positions. This reveals the central role and responsibility of outer players in the position and transition attack, manifested in the competitive efficiency of the teams the higher the actual quality of a pivot is, the bigger is the probability for high efficiency in the realisation of final actions in attacks in the mentioned position which is also evident in the number of goals which contribute to the competitive success of a certain team. Despite the obtained results, we must emphasize the limits of this research. Situation efficiency parameters of final actions describe partially, but not completely the players' and teams' efficiency in a handball match. On the other hand, there are many other factors which influence activity and quality of the opponents' defence (individual, team, goalkeeper), the level of the competition and motivation, all of which have not been considered in this research.

Thus, e.g. manifest variables, such as the number of shots on goal from closer positions (wing and pivot position), may not be the result of individual players' quality, but the of playing tactics model focused on creating selective shots from line positions. The discussion based on the obtained results proves the winning teams had more values and dominated in all the situation efficiency variables studied in this research. All this is reflected in the difference in the performance quality of the winning teams with relation to the defeated teams. Practical value of this paper is characterised by the idea of the importance of shot selection in outer players which is immediately manifested in the competitive efficiency of players and teams. At the same time it is important to stress that given facts can be used for selection of players, team selection, rational managing of the process of sport preparation, modelling of playing tactics and the evaluation of training interaction influences. Future research directions should encompass a larger number of standard and non-standard variables as well as the obtained situation efficiency indicators as data base of individual and team playing. Situation efficiency indicators in playing are mutually functionally and inseparably connected. Thus certain facts cannot be properly explained if we take into account only the situation-related efficiency indicators, and ignore interaction in the course of a handball game. Therefore, we must interactively observe the contribution of certain variables of playing efficiency in defence and attack which actually influence the efficiency in final actions. We consider it necessary to determine new criteria systems to evaluate the actual quality in players in all the phases of the course of game. This initiates the forming of a combined model to assess complete efficiency in the players' and teams' playing which should be constructed by expert trainers and scientists-practitioners based on their professional knowledge and experience, for all the positions in the game.

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UTJECAJ SITUACIJSKE UČINKOVITOSTI NA REZULTAT RUKOMETNE UTAKMICE

Sažetak

Glavni cilj ovog rada je utvrđivanje i objašnjenje pobjeda i poraza momčadi temeljen na situacijskim indikatorima finalizacije napada u vrhunskom seniorskom rukometu. Analizirana je 101 utakmica odigrana za vrijeme Svjetskog Prvenstva za muškarce koje je održano u Hrvatskoj 2009. Analizirane su razlike (ANOVA) totalnog uzorka utakmica na raznim razinama natjecanja. U tu svrhu primjenjene su tri grupe varijabli šuta na gol: broj udaraca na gol, broj postignutih pogodaka i postotak realizacije u pozicijskoj igri i tranzitivnom napadu. Rezultati istraživanja pokazuju da je utjecaj situacijskih varijabli na konačni rezultat rukometne utakmice niži kod suparnika jednake kvalitete, i viši kod veće razlike u kvaliteti. Pobjedničke momčadi su učinkovitije u svim parametrima finalnih akcija napada. Broj pogodaka s pozicije pivota značajno doprinosi pobjedi kod kvalitetnih momčadi. Rezultat rukometne utakmice između dvije kvalitetne momčadi određen je učinkovitošću šutiranja s vanjskih pozicija što sugerira koliko su važni vanjski igrači u kreaciji rezultata u vrhunskom rukometu. Ograničenja ovog istraživanja leže u činjenici da situacijski određeni parametri finalnih akcija opisuju samo djelomično, ne i potpuno, učinkovitost igrača i momčadi u rukometnoj igri. Za buduća istraživanja, neophodno je kreirati kombinirani model evaluacije potpune efikasnosti igre igrača i momčadi povezivanjem objektivno prikupljenih podataka o situacijskoj efikasnosti rukometaša.

***Ključne riječi**: natjecateljski rezultat, rukomet, varijable situacijske efikasnosti, finalizacija napada*

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PREDICTIVE VALIDITY OF MORPHOLOGICAL AND MOTOR VARIABLES FOR THE EVALUATION AND MONITORING OF THE KARATE FREE KATA PERFORMANCE

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Abstract

A system of 25 dependent variables, and 1 criterion variable, were analysed in 82 karate-practicing boys aged 10-14. There were 12 morphological variables, 12 basic motor skills variables, and the free kata performance as the only criterion variable. The purpose of this study was to determine specific influences of morphological and basic motor variables' systems on the criterion variable (free kata performance), and also to create a battery of instruments for the diagnostics, evaluation, monitoring, and assessment of the free kata performance based on this prediction model, via the regression analysis and stepwise statistics. The results demonstrated that the multi-variable predictive system of morphological variables did not have a statistically significant influence on the criterion variable (free kata performance)(p= .08). However, following stepwise method procedures, the influence was indeed significant (p= .00), as it was for basic motor variables (p= .00). From the reduced system of morphological variables, arm skinfold (p= .00), chest girth (p= .03), and leg length (p= .04) had the highest and statistically significant predictive validity (univariate). Within the reduced system of basic motor variables, it was shown that standing broad jump (p= .00), foot tapping (p= .01), 20m dash (p= .02), deep forward bend on the bench (p= .03), and situps in 30sec (p= .04) had the highest and the most significant predictive validity for the free kata performance. Based on these findings, the following test battery for the diagnostics, evaluation, monitoring, and assessment of the free kata performance may be constructed: upper-arm skinfold, chest girth, leg length, standing broad jump, foot tapping, 20m dash, deep forward bend on the bench, and sit-ups in 30sec.

Key words: *boys, morphological characteristics, motor abilities, free kata, predictive validity*

Introduction

Modern karate has required more contemporary approaches, concepts, forms, contents, and procedures in the training process with young karate athletes. This is particularly true for the structure of anthropological characteristics, their relationships and influences on high-level performance in sports, as well as the evaluation of the diagnostic and predictive validity of measuring instruments constructed for diagnostics, modeling, planning, programming, and controlling the effects of an operationalised training process (Doder; Doder & Malacko, 2008; Malacko & Doder, 2008; Doder et al., 2009). Predictive (prognostic) validity of measuring instruments in a sport activity is determined with the purpose of predicting a young person's athletic performance based on his/her tested anthropological characteristics and movement structures. This procedure is run in such a way that relevant anthropological characteristics and abilities are assessed in relation to sport performance/results (or situational movement structures), after which their predictive validity is calculated. This relationship (multivariate or univariate) is then further analysed and defined between a single performance variable or a whole system of situational/criterion variables and the system of selected predictive variables. The procedure is normally done by the regression and/or stepwise (reduced) analyses (Malacko & Popovic, 2001).

A karate kata is usually defined as a performance of set sequences of basic techniques (stances, hand punches and leg kicks and strikes) in a fight with an imaginary opponent (Stricevic, 1997). The structural components of a kata are: technique, application and rhythm. Katas are classified relative to the time and place of their origin (okinawan, chinese and japanese). Katas can also be classified into pupil and master katas (Funakoshi, 1995). During the late 1920s and early 1930s, Funakoshi modified a certain numbers of katas in order to make them more appealing to the public. Kata competitions represent a kind of either individual or team performance of symbolic forms which are carefully defined by the performers' formation lines, sequence and rhythm of karate techniques. The quality of a kata performance is judged based on the elements of form, speed, strength and power, hip rotations, relationships of forces, extremities' positions, kimeas, breathing, rhythm, balance, preparatory and final position/stance. Technique is thought to be one of the key elements in the evaluation of kata quality, with the explosive strength of legs, and the speed of hand punches and hits, being the most important factors for kata performance. Repetitive strength of the abdominal musculature, as well as the hip and spine flexibility related to explosive strength and movement speed, are also relevant factors for the quality of kata performance (Babiak & Doder, 2009; 2010).

Problem and aim

The aim of this study was to determine the influence of a predictive system of morphological and basic motor variables on the criterion variable (free kata performance) in karate-trained boys by using regression-reduction statistical procedures. Secondly, based on the calculated predictive (prognostic) validity, a test battery of instruments would be designed for the evaluation and monitoring of relevant parameters aimed at meaningful planning, programming, and controlling the effects of an operationalised training process.

Methods

Sample
82 boys, aged 10-14 y, from 18 different karate clubs from all over the Province of Vojvodina, participated in the study.

Variables
There were 25 variables altogether, including 1 criterion variable, 12 predictive morphological, and 12 predictive motor variables. The evaluation of the free kata performance, as the single criterion variable, was done by a committee of five independent evaluators. All participants did one of the master's katas of their own choice from the list of the Serbian Karate Federation. The evaluators' committee awarded the marks from 1-5. Following a candidate's kata, each member gave his own mark which was then recorded, and the average mark was given to each candidate for his performance (Doder, 2000). The following predictive variables were sampled for the evaluation of morphological characteristics: longitudinal dimensionality of skeleton - 1. *body height* (BODHEI), 2. *leg length* (LEGLEN), 3. *arm length* (ARMLEN); transverse dimensionality of skeleton - 4. *shoulder width* (SHOBRE), 5. *pelvis width* (PELBRE), 6. *wrist diameter* (WRIDIA); body voluminosity - 7. *chest girth* (CIRCUM), 8. *forearm girth* (FORGIR), 9. *body mass* (BODMAS); *subcutaneous body fat* - 10. *upper-arm skinfold* (TRICSK), 11. *abdominal skinfold* (ABDSKI) and 12. *subscapular skinfold* (SUBSKI). Metric characteristics of all morphological variables have previously been validated (Stojanovic et al., 1975). The following predictive variables were used for the evaluation of basic motor abilities and mechanisms: movement structuring - 1. *coordination in the air* (AGIAIR), 2. *arm plate tapping* (HANDTA), 3. *foot tapping* (FOOTTA); tonus regulation and synergistic action - 4. *deep forward bend on the bench* (SBENCH), 5. *one-leg balancing on the beam* (BALBEA), 6. shoulder flexibility test with stick (STYARD); regulation of excitation duration - 7. *sit-ups in 30 sec* (P-UPAB), 8. *push-ups on parallel bars* (H-SQWW), 9. half-squat with load (S-U30S); regulation of excitation intensity - 10. *standing broad jump* (L-JFSS), 11. standing triple jump (T-JFSS) and 12. *20m dash* (20MRFS). Metric characteristics of these basic motor variables have previously been validated by a number of studies (Gredelj et al., 1975; Kurelic et al., 1975).

Data processing
The following central and dispersion parameters were determined for each variable: mean (M), standard deviation (S), standard error of the mean (Se), minimal value (min), and maximal value (max). The normalcy of distribution was tested by skewness (Sk) and kurtosis (Ku). Respective influences of morphological and basic motor variable systems (as two systems of predictive variables) on the criterion variable were analysed by regression analysis. In this procedure, the following univariate statistical parameters were applied: the influence of each standardized predictive variable on the criterion variable (β), testing of the significance of each predictive variable's influence on the criterion variable (t), and statistical significance of each predictive variable's influence on the criterion variable at p= .05- .00. Multivariate values were drawn based on the following parameters: multiple correlation squared (R_o^2), multiple correlation between the entire system of predictive variables and criterion variable, testing of significance by F-test (F), and statistical significance of the influence of the entire system of predictive variables on the criterion variable at p= .05- .00. In regression analysis, the stepwise method was used, a model that is essentially based on a gradual introduction of variables (one at the time, or step-by-step) in the order from the highest to the lowest multivariate and univariate predictive influence and its calculated statistical significance (p). The purpose of this model is to find the best possible regression procedures explaining specific criterion variables, and also to determine and analyse relative influences of each of the tested variables (expressed in percents) on criterion variables, both as a system and individually. In this way, one can reach an optimal assessment of statistically significant predictive values of tested variables (prognostic validity), according to their optimally reduced number, multivariate and univariate coefficients of multiple correlation (R_o), multiple correlation squared (R_o^2), and individual multiple correlation squared (R_o^2)(p).

Results

Analysing Table 1, it is clear that most morphological variables do not disperse significantly from normal distribution. The only exceptions were *Subscapular skinfold* (Sk=2.35), *Abdominal skinfold* (Sk=1.67), and *Pelvis width* (Sk=1.23), whose positive values of asymmetry (epikurtosis) may suggest that young karate players have a somewhat wider pelvis and higher subcutaneous fat. Most basic motor variables also stay fairly close to the normal distribution curve. This shows that the selected tests were discriminative enough, except for *One-leg balancing on the beam* (Sk=2.25), *Push-ups on parallel bars* (Sk=1.64), and *Deep forward bend on the bench* (Sk=-1.17), for which the distribution is asymmetric.

Table 1. Basic statistical parameters (morphological and motor) variables.

Variable	M	S	Se	Min	Max	Sk	Ku
	Morphological variables						
BODHEI (cm)	149.88	13.16	1.45	120.9	182.40	.21*	-.43
LEGLEN (cm)	86.05	7.72	.85	71.7	104.30	.16*	-.67
ARMLEN (cm)	63.19	6.26	.69	49.6	79.10	.28*	-.33
SHOBRE (cm)	31.98	3.17	.35	25.1	41.50	.21*	.08
PELBRE (cm)	23.23	2.77	.30	15.9	36.40	1.23	5.39
WRIDIA (cm)	4.80	.46	.05	3.9	5.90	.11*	-.52
CIRCUM (cm)	70.35	7.96	.87	56.5	91.50	.38*	-.43
FORGIR (cm)	21.05	2.26	.25	17.1	29.20	.66*	1.10
BODMAS (kg)	39.68	11.05	1.22	20.0	72.00	.53*	-.07
TRICSK (mm)	10.64	4.35	.48	1.6	23.60	.89*	.57
ABDSKI (mm)	10.83	8.53	.94	2.4	40.00	1.67	2.38
SUBSKI (mm)	9.50	5.41	.59	4.0	34.80	2.35	6.58
	Motor variables						
AGIAIR (sec)	15.30	1.79	.19	11.8	20.00	.55*	.49
HANDTA (fr)	41.37	6.70	.74	24.0	55.00	.09*	-.16
FOOTTA (fr)	53.87	5.61	.61	32.0	66.00	-.55*	1.80
SBENCH (cm)	42.95	6.61	.73	17.0	53.00	-1.17	2.57
BALBEA (sec)	14.31	9.57	1.05	1.7	59.20	2.25	7.69
STYARD (cm)	5.99	1.19	.13	2.3	8.60	-.58*	.78
P-UPAB (fr)	23.12	3.31	.36	15.0	34.00	-.08*	.90
H-SQWW (sec)	1.62	2.14	.23	.0	8.00	1.64	2.07
S-U30S	4.69	2.05	2.26	4.0	11.40	.73*	1.08
L-JFSS (cm)	161.13	25.61	2.82	105.0	240.00	.11*	-.01
T-JFSS (cm)	502.20	71.15	7.85	313.0	700.00	.32*	.27
20MRFS (sec)	3.83	.35	.03	3.1	4.80	.18*	-.15

Legend: M - mean, min, max – minimal and maximal result, S - standarddeviation, Se – standard error of the mean, Sk - skewness, Ku – kurtosis; Morphological variables: body height (BODHEI), leg length (LEGLEN), arm length (ARMLEN), shoulder width (SHOBRE), pelvis width (PELBRE), wrist diameter (WRIDIA), chest girth (CIRCUM), forearm girth (FORGIR), body mass (BODMAS), upper-arm skinfold (TRICSK), abdominal skinfold (ABDSKI), and subscapular skinfold (SUBSKI). Motor variables: coordination in the air (AGIAIR), arm plate tapping (HANDTA), foot tapping (FOOTTA), deep forward bend on the bench (SBENCH), one-leg balancing on the beam (BALBEA), s shoulder flexibility test with stick (STYARD), sit-ups in 30 sec (P-UPAB), push-ups on parallel bars (H-SQWW), half-squat with load (S-U30S), standing broad jump (L-JFSS), standing triple jump (T-JFSS), 20m dash (20MRFS).

From Table 2 one can observe no statistical significance of the influence of the system of predictive morphological variables on the criterion variable (OSKATE), so there will be no further analysis of this finding. However, the stepwise method revealed that a reduced system of four variables had a significant influence on the criterion variable (OSKATE) at .00(p= .00). Multiple correlation was .46 (R_o= .46), while multiple correlation squared was .21 (R_o^2= .21), which essentially means that some 21% of the criterion variable could be explained by a reduced system of morphological variables.

Specifically, significant predictive validity was attributed to *Upper-arm skinfold* (p= .00) (explains 10% of the total variance), *Chest girth (*p= .03), and *Leg length* (p= .04), both accounting for 4% of the total variance. Table 3 indicates that the entire system of basic motor variables significantly influenced the criterion variable (OSKATE) at .00 (p= .00). Additionally, multiple correlation was .64 (R_o= .64), while multiple correlation squared was .41 (R_o^2= .41), explaining about 41% of the total variance.

Table 2. The influence of the system of predictive morph. variables on the criterion variable (OSKATE)

Variable	β	E(β)	t	p	
BODHEI	-.27	.45	-.60	.54	
LEGLEN	.62	.28	2.23	.02*	
ARMLEN	-.23	.30	-.76	.44	
SHOBRE	.02	.23	.08	.92	
PELBRE	.09	.14	.59	.55	
WRIDIA	-.01	.21	-.07	.93	
CIRCUM	-.35	.22	-1.58	.11	
FORGIR	.13	.25	.52	.60	
BODMAS	-.06	.42	-.14	.88	
TRICSK	.30	.14	-2.07	.04*	
ABDSKI	-.02	.17	-.17	.86	
SUBSKI	-.07	.18	-.38	.69	
	Ro^2=.23 Ro=.48 F=1.71 p=.08				
	Predictive validity				
	Ro	Ro^2	Ro^2 (p)	F	p
TRICSK	.32	.10	.10	9.51	.00*
CIRCUM	.39	.15	.04	4.45	.03*
LEGLEN	.44	.20	.04	4.33	.04*
ARMLEN	.46	.21	.01	1.69	.19
	Ro^2=.21 Ro=.46 F=5.30 p=.00*				

Legend: R_o- multiple correlation; Ro^2- predictive validity of entire system; Ro^2 (p)- individual predictive validity; F- F-value; p- statistical significance of the influence of reduced system of variables. Variables: upper-arm skinfold (TRICSK), chest girth (CIRCUM), leg length (LEGLEN), arm length (ARMLEN).

Among the motor variables, the greatest and statistically significant predictive validity was attributed to *Foot tapping* (p= .01), *Deep forward bend on the bench (*p= .01), *20m dash* (p= .02), *Sit-ups in 30 sec* (p= .02), *Standing broad jump* (p= 03), and *Arm plate tapping* (p= .04). Stepwise analysis showed that the reduced system of five predictive basic motor variables had a significant influence on the criterion variable (OSKATE) at .00 (p= .00). Multiple correlation was .64 (R_o= .64), while multiple correlation squared was .41 (R_o^2= .41), hence explaining about 41% of the criterion variable. The most significant predictive validity was attributed to *Standing broad jump* (p= .00), explaining some 16% of the total variance, *Foot tapping* (p= .01) and *20m dash* (p= .02) explaining 5%, *Deep forward bend on the bench* (p= .03) with 4%, and *Sit-ups in 30 sec* (p= .04), accounting for 3% of the total variance.

Discussion and conclusions

In contemporary expert literature, predictive validity of variables for the evaluation and monitoring of an athlete's anthropological status is designed, modeled, and programmed according to exact sports technological and methodological procedures. These procedures or models are based on constructing a hierarchical structure in which dominant or relevant anthropometrical characteristics and movement structures are placed in the order – from the greatest to the least - of the extent and significance of their influence on sports performance/results, as determined by the regression analysis method.

Table 3. The influence of the system of predictive motor variables on the criterion variable (OSKATE)

Variable	β	E(β)	t	p	
AGIAIR	.00	.11	.05	.95	
HANDTA	-.24	.11	-2.09	.04*	
FOOTTA	.27	.11	2.48	.01*	
SBENCH	.27	.11	2.38	.01*	
BALBEA	-.11	.10	-1.11	.27	
STYARD	.07	.10	.66	.50	
P-UPAB	.28	.12	2.35	.02*	
H-SQWW	-.04	.11	-.38	.70	
S-U30S	.04	.11	.36	.71	
L-JFSS	.50	.22	2.20	.03*	
T-JFSS	-.24	.15	-1.56	.12	
20MRFS	.29	.12	2.34	.02*	
	Ro^2 = .41 Ro=.64 F=4.12 p=.00*				
	Predictive validity				
	Ro	Ro^2	Ro^2 (p)	F	p
SKODAL	.40	.16	.16	15.69	.00*
TAPNOG	.47	.22	.05	5.77	.01*
TRČ20M	.52	.27	.05	5.52	.02*
DUPRED	.56	.31	.04	4.86	.03*
DIZTRU	.59	.35	.03	4.02	.04*
	Ro^2 = .41 Ro=.64 F=6.36 p=.00*				

Legend: R_o- multiple correlation; Ro^2- predictive validity of entire system; Ro^2 (p)- individual predictive validity; F- F-value; p- statistical significance of the influence of reduced system of variables. *Variables:* standing broad jump (L-JFSS), foot tapping (FOOTTA), 20 m dash (20MRFS), deep forward bend on the bench (20MRFS), sit-ups in 30 sec (P-UPAB)

If there are high and statistically significant correlation coefficients among them, it is a strong indication that there are meaningful and well-constructed movement structures and anthropological characteristics and abilities that can be activated with the purpose of diagnostics and/or athletic training. The regression analysis results in this study suggest that the applied system of morphological variables, as a whole, does not have a significant influence on the criterion variable (free kata performance, OSKATE)(p= .08). However, the stepwise method demonstrated there was indeed a significant influence of a reduced system of predictive morphological variables on the criterion variable at .00 (p= .00). Within the reduced system, the greatest and most significant predictive validity for the free kata performance was attributed to *Subscapular skinfold*, *Chest girth*, and *Leg length*. These findings indicate that boys with a lower upper-arm skinfold, greater chest girth, and longer legs, may be more successful in the free kata performance.

The regression analysis of basic motor variables also revealed a statistically significant influence of the predictive system as a whole on the criterion variable (OSKATE) at .00 (p= .00), mostly thanks to six individual variables (*Standing broad jump, Foot tapping, 20m dash, Deep forward bend on the bench, Sit-ups in 30 sec, and Arm plate tapping*). The stepwise method further reduced the system to five predictive basic motor variables (*Standing broad jump, Foot tapping, 20m dash, Deep forward bend on the bench, and Sit-ups in 30 sec*). From these results, a conclusion may be drawn that boys with greater explosive strength of legs, higher frequency of alternating arm movements, better flexibility in the pelvic area, and greater strength of the abdominal musculature, were more successful in the free kata performance (OSKATE). In conclusion, by determining the predictive (prognostic) validity through regression analysis and the stepwise method, the following battery of measuring instruments is proposed for the diagnostics, evaluation, monitoring, and assessment of kata performance: upper-arm skinfold, chest girth, leg length, standing broad jump, foot tapping, 20m dash, deep forward bend on the bench, and sit-ups in 30 sec.

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PREDIKTORSKA VALJANOST MORFOLOŠKIH I MOTORIČKIH VARIJABLI ZA PROCJENU I PRAĆENJE IZVOĐENJA SLOBODNE KATE U KARATEU

Sažetak

Na uzorku 82 karatista, uzrasta od 10 do14 godina, bio je primjenjen sustav od ukupno 25 varijabli, od toga 12 morfoloških, 12 bazičnih motoričkih (kao sistema prediktorskih varijabli) i jedne varijable izvođenja slobodne kate (kao kriterijska varijabla). Cilj istraživanja je bio da se utvrdi utjecaj sustava morfoloških i sustava bazično-motoričkih varijabli na kriterijsku varijablu za procjenu uspješnosti izvođenja slobodne kate, a zatim da se izvrši konstrukcija baterije mjernih instrumenata za dijagnosticiranje, procjenu, praćenje i vrednovanje izvođenja slobodne kate na osnovu njihove prediktorske valjanosti, primjenom statističke metode regresijske analize i stepwise metode. Rezultati su pokazali da prediktorski sistem morfoloških varijabli (multivarijantno) nije imao statistički značajan utjecaj na kriterijsku varijablu slobodne kate (p=.08), ali je zato dobiven primjenom stepwise metode (p=.00), dok je kod bazično motoričkih varijabli bio na razini .00 (p=.00). Od reduciranog sistema morfoloških varijabli najveću i statistički značajnu prediktorsku valjanost (univarijantno) imaju kožni nabor nadlaktice (p=.00), srednji obujam grudnog koša (p=.03) i duljina nogu (p=.04). U prostoru reduciranog sistema bazično-motoričkih varijabli statistički značajnu prediktorsku valjanost procjene uspješnosti izvođenja slobodne kate imaju skok u dalj s mjesta (p=.00), taping nogom (p=.01), trčanje na 20 metara s visokim startom (p=.02), duboki pretklon na klupici (p=.03) i dizanje trupa za 30 sekundi (p=.04). Shodno ovako dobivenim rezultatima, može se konstruirati slijedeća baterija mjernih instrumenata za dijagnosticiranje, procjenu, praćenje i vrednovanje izvođenja slobodne kate: kožni nabor nadlaktice, srednji obujam grudnog koša, duljina nogu, skok u dalj s mjesta, taping nogom, trčanje na 20 metara visokim startom, duboki pretklon na klupici i dizanje trupa za 30 sekundi.

***Ključne riječi**: dječaci, morfološke značajke, motoričke značajke, slobodne kate, prediktorska valjanost*

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EFFECT OF EXPERIMENTAL TAE BO TRAINING MODEL FOR COORDINATION DEVELOPMENT OF YOUNG WOMEN

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Original scientific paper

Abstract

The study included 60 subjects, 18 to 25 years of age divided into a group of 30 young women involved in an experimental tae bo training model (experimental group) and a group of 30 young women who are not involved in any program of regular physical exercise (control group). In order to test the level of general coordination, seven tests were used: the figure "8" with bending (MOSS), jumping over the rope (MPHV), 20 steps forward with the pulling of the stick through the legs (M20IPP), ball circling around the body and through the legs (MKTN), hand slalom with two balls (MSLAL), 3 forward rolls (M3KOL) and complex locomotor test (MSLT). Data were processed by analysis of variance, t-test and analysis of covariance. The results showed that there is statistically significant effect of experimental tae bo training model on the development of general coordination among younger women.

Key words: *Tae Bo training, coordination, younger women*

Introduction

Tae Bo is a model of aerobic exercise which was founded by Billy Blanks, which combines the best of the many existing variants of exercise. It is a combination of self awareness and control of military skills, the center and power of boxing, charm and rhythm of dance (Blanks, 1989). In aerobics, the tempo of music determines the intensity of exercise, faster tempo intensive work (high impact), and the slow tempo imposes lower intensity exercise (low impact) (according to Despić, 1997, 198). The word itself was formed from the initial syllables of two sports - taekwando and boxing. Blanks later explained the name of tae bo (Total Awareness Excellence Body Obedience), and in 1989. it began with a combination of music and the elements of taekwando and boxing, to achieve more intensive training. Tae Bo includes kicks from karate, but it is not intended for fighting or self-defense. There are no takedowns, wrestling or fighting on the ground. It has been created to improve health, promote fitness and endurance through movement. Tae Bo includes aerobic exercises, it increases the capacity of the heart and lungs, flexibility, it burns calories, it reduces stress, and it strengthens the muscles of the body. These high-intensity exercises are among the cardio vascular exercises, they affect the strength, muscular endurance, flexibility, and they develop a general body coordination. Coordination is an ability of performing simple and complex movements, but also rapid learning of new movement and quick change of one movement with another (Drabik, 1996). This type of movements require the cooperation of many parts of the body without excessive mental strain with less errors and effort. For people who have developed this capability at a high level, there is the possibility of correcting errors in the execution of the movements. Coordination is caracterized by the use of muscles or muscle groups that are most appropriate to requested movement. On that occasion, the synchronization higher regulatory centers and peripheral parts of the locomotor apparatus is performed (Metikoš et al., 2003). Coordination is associated with the technique of the sport or sport disciplines. Coordinated movements are faster, more economical and more efficient (Bompa, 2005). Coordination is influenced by (by Drabik, 1996) sportsmen's intelligence, acquired motor skills and level of development of other motor skills. Most researchers (Bompa, 1999; Drabik, 1996; Hirtz & Starosta, 2002) consider that the primary coordination skills should be developed by the beginning of puberty, exactly from sixth to twelveth year, which is called "sensitive phase". During puberty, there is stagnation, because this period is characterized by rapid growth and development of the organism, but after leaving it condition is improving. Researches show (Stojiljković, 2003, Stanković, 2004) that coordination has multiple dimensions: coordination of the arms, legs and body, dexterity, agility, timeliness, tempo, rhythm coordination, reorganization of stereotyped movements, the speed change of moving direction, the general static and dynamic coordination, fine and gross body coordination, coordination of strong movement performance, motoric education and motoric intelligence. The aim of this study was to determine the effect of experimental tae bo training model on the development of general coordination among younger women.

Methods

The study involved 60 female subjects, 18 to 25 years of age. The sample was divided into two sub-samples: 1. A group of 30 young women involved in an experimental tae bo training model (experimental group), 2. A group of 30 young women who are not involved in any program of regular physical exercises (control group).

In order to check the level of general coordination, the seven tests have been used: the figure "8" with bending (MOSS), jumping over the rope (MPHV), 20 steps forward with the pulling of the stick through the legs (M20IPP), ball circling around the body and through the legs (MKTN), hand slalom with two balls (MSLAL), 3 forward rolls (M3KOL) and complex locomotor test (MSLT). Data were processed by analysis of variance, t-test and analysis of covariance.

Experimental program

The structure of the three months training period (36 hours, three times a week) had a conception of tae bo aerobics with fast tempo music of 135 to 155 beats per minute. Trainings are conducted in the aerobics studio NIA in terms of optimum temperature of 18 to 22 degrees. This model of training is intended for all levels of aerobic endurance developing. It includes the performance of manual and leg elements of boxing, karate and taekwondo technique, combined in a simple choreographies which provides muscular tone of the entire body. This model of exercise improves body coordination, raises aerobic endurance and functional capacity while reduces weight. Temporal structure of the training consisted of three parts:

1. *Introduction* (heating) lasts for five minutes. First of all it need to raise the whole body temperature and to increase blood flow in the body. Tempo of music in this part is from 100 to 120 tacts per minute. Following steps are applying: *Walk, Jogging, Step Touch, Double Step Touch, Leg Curl, Double Leg Curl, Knee Up, Up Double Knee*. The purpose of the introductory phase is to prepare the body for the next strain with simple choreography, composed of the basic steps of walking and jogging in place and motion.

2. *The main part* - contains two separate parts:

Aerobic part - duration of this part is 30 minutes and it consists of movement, blocks and sequences of movements that are directed to the development of cardiovascular and respiratory systems. The steps are clearly defined and used in popular international terms typical model for the tae bo training: *Jab, Hook, Cross, Upper Cut, Kick (front, side, back)*. In the aerobic part there are 24 repetitions by one leg, than another one, also by hands. This number of repeats is predicted for the first mesocycle of 12 training and for the next mesocycle the number of increases for four repetitions. For the last mesocycle another four repetitions are planned. The break is one minute.

Body shaping exercise - this part of the training focuses on exercises for shaping and strengthening the body. In every training the series of exercises is applying for different muscle groups. Music tempo is from 100 to 120 tacts per minute. During the implementation of this part of the training, cardio-respiratory load of the system is low. Strengthening exercises are used for:

- hand and shoulder muscles
- abdominal muscles
- back muscles
- gluteal muscles
- leg muscles

Length of this part of the training is 20 minutes. First 10 minutes is for treated muscle group, performing three to five series with the number of repeats from 16 to 20 (the first mesocycle 16, the second 18 and third 20). Another 10 minutes is for strengthening exercises for abdominal muscles.

3. *The final part* - the duration of this part is five minutes with content devoted to stretching exercises and relaxation in order to calm the body. Tempo of the music is from 40 to 60 tacts per minute. Static stretching exercise (stretching) are implemented. Each drill is performed in the sustain period of 20 seconds. The choice of exercises depends on the muscle groups that engage in exercise for body shaping.

Results

Analysis of variance between experimental and control groups at the initial measurement

Table 1. Multivariate analysis of variance between experimental and control groups in the general coordination of the initial measurement

Wilks' Lambda	F	P
0.753	2.440	0.031

Table 2. Univariate analysis of variance between experimental and control groups in the general coordination of the initial measurement

Variable	Mean (E)	Mean (K)	F	P
MOSS	25.16	25.30	0.03	0.86
MPHV	5.76	4.53	3.39	0.07
M20IPP	17.16	17.32	0.03	0.85
MKTN	16.92	17.45	0.47	0.50
MSLAL	12.58	12.84	0.20	0.66
M3KOL	4.11	4.50	3.84	0.05
MSLT	18.20	18.45	0.08	0.78

Analysis of the difference between the initial and final measurements of the experimental group studied by T-test

Table 3. Significant difference between the arithmetic means of measured group

Measure.	Mean(i)	Mean(f)	T-value	p
MOSS	25.16	23.57	2.18	0.03
MPHV	5.77	7.57	-2.79	0.01
M20IPP	17.17	14.76	3.42	0.00
MKTN	16.93	15.04	2.94	0.01
MSLAL	12.58	11.43	2.42	0.02
M3KOL	4.11	3.56	3.33	0.00
MSLT	18.21	15.72	2.94	0.01

Analysis of covariance between the experimental and the control group at the final measurement

Table 4. Multivariate analysis of covariance between the experimental and control groups in the general coordination of the final measurement

Wilks' Lambda	F	Effect df	Error df	P
0.4	9.79	7	45	0.00

Table 5. Univariate analysis of covariance between the experimental and control groups in the general coordination of the final measurement

Measure.	Adj. Mean (E)	Adj. Mean (K)	F	P
MOSS	24.58	25.11	8.25	0.00
MPHV	6.21	6.15	6.03	0.00
M20IPP	16.68	17.09	9.49	0.00
MKTN	16.32	16.61	4.45	0.00
MSLAL	12.37	12.38	7.60	0.00
M3KOL	3.94	3.98	6.50	0.00
MSLT	17.40	18.15	8.86	0.00

In Table 1 there are results of significance difference of arithmetic means of all general coordination tests between the experimental and control groups initial measurement. It was found statistically significant differences, as Wilk's lambda is .399 and Rao F-approximation of 2.44 gives significant differences in level of P = .031. Based on the F coefficients and their significance (P) it can be concluded that there are no statistically significant difference in any of the general coordination tests between the experimental and control groups, except for test 3 forward rolls (M3KOL .045). Table 3 contains the results of T-test of motor skills between the initial and final measurements of the experimental group. After analyzing the results it can be concluded that there are a statistically significant differences in the level of all coordination tests: the figure “8” with bending (MOSS .033), jumping over the rope (MPHV .007), 20 steps forward with the pulling of the stick through the legs (M20IPP .001), ball circling around the body and through the legs (MKTN .005), hand slalom with two balls (MSLAL .019), 3 forward rolls (M3KOL .002) and complex locomotor test (MSLT .005). The results of multivariate analysis of covariance (Table 4) between the experimental and control groups at the final measurement point to the presence of statistically significant difference in favor of the experimental group in the level of general coordination at the level of P = .000. The difference was influenced by the experimental tae bo training model, which had a positive influence on the general coordination transformation processes at the experimental group. On the Table 5 there are univariate values of analysis of covariance between the experimental and control groups at the final measurement with the neutralization of differences in the field of general coordination in the initial measurement. There are statistically significant differences between groups (P< .01) in the favor of the experimental group at the level of all general coordination tests: the figure “8” with bending (MOSS .000), jumping over the rope (MPHV .000), 20 steps forward with the pulling of the stick through the legs (M20IPP .000), ball circling around the body and through the legs (MKTN .000), hand slalom with two balls (MSLAL .000), 3 forward rolls (M3KOL .000) and complex locomotor test (MSLT .000).

Discussion and conclusion

The modern way of life, and inadequate treatment of the natural need for movement, lead to disturbances in the functioning of certain organs and organic systems. Researches suggest (Cooper, 1976; Strømme et al., 1996) that by dealing with regular physical exercise, it may affect the reduction of negative consequences of modern living on the body. Physical activity in that regard participate in maintaining of the working capacity and improving subjective feelings of people. Preservation of functional capacity, cardiovascular (Radovanović et al., 2008), respiratory, motor and nervous systems can be influenced by the regular practice of physical exercise. In addition to aerobic exercises, it is recommended to practice exercise programs for the development of endurance, mobility and coordination. One of these programs is the recreational tae bo training model, that develops aerobic endurance, strength, mobility and coordination. In their research Boeva et al (2003) came to similar conclusions, indicating an increase in physical abilities of the respondents after the implementation of the experimental model of Tae Bo aerobics. They also observed a positive impact on health status and motivation in dealing with other forms of physical exercise. Of many benefits that Tae Bo workout can make it should mention the reduction in body mass, circular dimensionality and some subcutaneous fat (Petković, Veselinović & Stojanović, 2007). Tae Bo affects those who practice in terms of self-discipline, strengthening the entire body, toning muscles of individual body parts and a beneficial effect on cardiac work (Tae Bo Cardio - basic idea of creator of the Tae Bo exercise was beneficial impact on cardiovascular work). In addition to influencing on the body in the physical sense, it should be noted that this form of recreational exercise was designed to improve mental acuity, self-confidence, self-awareness, and getting to know the basics of different martial arts Tae Bo was formed, which can ultimately help on the occasion of self-defense. In the study of Daniel Landers (1997) from Arizona State University conclusions were derived in favor of positive impact on mental health in the form of relieving symptoms of depression and anxiety. This form of recreational exercise is becoming increasingly popular, especially among women, although not designed exclusively as an activity for women. But very few men interested in Tae Bo, which may be explained by recent appearance of this kind of exercise and the inability to measure so quickly with many other famous (male) sports. Those cited researches have shown that physical activity may contribute to successful body shaping and healthier lifestyle. Therefore, if you take one hour per day, three times a week, it is not a "loss" if you want to get a different dimension of a very high quality spent free time. It is very pleased to present the fact that there are more and more those who practice of different ages who become aware of the great problem of modern man - hypokinesis. In the constant struggle for survival and providing financial security to his family, a man forgets of hisself and his body which has a negative impact on quality of life. Therefore, this type of recreational exercise can be considered as an effective solution. Tae Bo workout essentially has a positive effect on the entire human body, regardless of the initial desire of everyone who practices.

Coordination is only one segment of the anthropological status, however, that was enough to show the efficiency in the case of proper execution of exercise. There is no doubt that positive transformative processes would be also found with other anthropological dimensions. This research has shown that general coordination among younger women can be improved by the planned and systematic working with Tae Bo training model. The results showed that there is statistically significant effect of experimental models of Ta bo exercise on the development of tests of coordination among younger women at the level of P = .000. Featured program of experimental Tae Bo training model can serve as a starting point for future researches in this field.

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EFEKTI EKSPERIMENTALNOG TAE BO TRENAŽNOG MODELA NA RAZVOJ KOORDINACIJE MLADIH ŽENA

Sažetak

Istraživanje je uključilo 60 subjekata, 18 do 25 godina podijeljenih u dvije grupe: 30 mladih žena uključenih u eksperimentalni tae-bo trenažni model (eksperimentalna skupina) i grupu od 30 mladih žena koje nisu uključene ni u koji program regularnog tjelesnog vježbanja (kontrolna skupina). Radi testiranja razine opće koordinacije korišteno je sedam testova: figura "8" sa sagibanjem (MOSS), preskakanje konopca (MPHV), 20 stepova s provlačenjem štapa kroz noge (M20IPP), kruženje loptom oko tijela i kroz noge (MKTN), slalom s dvije lopte (MSLAL), 3 kotrljanja naprijed (M3KOL) i složeni lokomotorni test (MSLT). Podaci su obrađeni analizom varijance, t-testom i analizom kovarijance. Rezultati su pokazali da postoji statistički značajan efekt eksperimentalnog tae-bo trenažnog modela na razvoj opće koordinacije među mlađim ženama.

Ključne riječi: *Tae Bo trening, koordinacija, mlađe žene*

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STATISTICAL ANALYSIS OF TACTICAL ELEMENTS IN BASKETBALL GAMES

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Preliminary scientific communication

Abstract

The research topic is the analysis of basketball games and tactical understanding of the elements, their frequency and efficiency. The problem is statistical analysis of the tactical elements. The main aim is to establish a theoretical model as a guide for technical and tactical preparation that will result in improved efficiency. The task of research is to create a form for the successful monitoring and analysis of a basketball game in tactical terms. Method- variables: lead shot, shot punching, punching add a shot, shoot system, system entry feedback, extracted shot, single entry, system entry, system assists, system pivot, free throw, fine shot, translation, end of the game, jump, contra. The experimental treatment involves the separation of elements by observation of domestic league games, Final Four to the NBA. The method of data processing in SPSS 11.5. Descriptive statistics are processed by the coefficient, the arithmetic mean, average and sum the results. Results: two theoretical models of balance: a balance that shows the spatial distribution of the concepts of attack, whether the attack was completed in the field or directly under the basket and personal team balance that shows the distribution of individual and team attack. Conclusion: the established parameters for analysis. Based on observations at all levels of game it was up to 16 items that are recorded in summary form, and 11 items logged in the application forms for the balance. Based on the established 11 parameters games, appearing in all the matches, formed the model, which indicates the distribution of team work and physical activity.

Key words: *basketball, tactics, elements, analysis*

Introduction

Basketball will be treated with a similar position as a maze and puzzle, as well as mathematical and logical problems, which require careful observation, classification, analysis and synthesis, finally reaching certain conclusions. What is the purpose of basketball or more precisely, that the goal of players in the game? The goal is to be the shortest possible route, space and energy, came to reaching the basket. People who are not fans of sports, when you watch basketball often comment that the ground there, a chase after the ball. Not distinguish teams or players, let alone realize the technical and tactical elements. Few games are more adept understand the system and provide redundant comments, and often correct. As much as the man was an expert, though not with the naked eye to see all elements of the game and make a valid conclusion. Thanks to modern technology we can later review the match and carefully analyze all the parameters that contribute to success. The question is what are the parameters that should be recorded and analyzed, or in other words, to help our players to beat opponents. How to go through their labyrinth and how to solve the puzzle? As we see and know a lot of elements that are subject to statistical analysis. Existing statistics, which are kept on every game gives us a glimpse on the TV screen for points scored, rebounds in attack and defense, assists, etc… It is important that all this analysis is likely correct, but the parameters that have been proven not only to influence the final result. This shows the correlation, which is never one, but still small, leaving room for further research.

Researches in past show us all problem then we need. Basketball game can be viewed as an ordered sequence of tasks that each player needs to be done according to the place and role within a team concept game (Trninić, 1995). Basically, hierarchical structure of dimensions of athletes, given the success of the sports game (Milanović, 1999), situational efficiency parameters are located on the third level of the pyramid made up yet, the first level, anthropometric characteristics, then the second level of the pyramid are the specific skills and knowledge athletes, while the fourth level is the result of' sports. An analysis of basketball players movements in the Slovenian basketball league play-offs using the sagit tracking system (Erčulj & al, 2008).

Subject, problem and aim

The research topic is the analysis of basketball games and tactical understanding of the elements, their frequency and efficiency. The problem is statistical analysis of the tactical elements. The main aim is to establish a theoretical model as a guide for technical and tactical preparation that will result in improved efficiency, ie. existing concept of the game, if you deviate from the theoretical model, verified the correct parameters. Global research task is to create a form for the successful monitoring basketball games, as well as the form for later analysis. Specific objectives are to establish parameters for analysis, establish a theoretical model, compare the American and European concept of the game, compare the teams through the concept of the attack to form a conceptual image of a team attack.

Methods

The sample of variables: single shot, punch shot, add punch shot, system shot, enter feedback system shot, extracted shot, single entry, system entry, system assists, pivot system, free throw, interruption of shot, translation, end of the game, jump, contra. Experimental treatment: separation of the elements described in this paper was done by observing 30 games of all levels of competition - from students to the NBA league. It was noted that in all leagues repeat the tactical elements, in this case concepts. Observation is only recorded what was happening on the ground. Technical elements are also shown, but not as a target group but as an asset. When the variables are finally established as a relatively stable, followed by the NBA games, ending the Adriatic League, qualifying and finals Euro Cup in Berlin (Final Four). Instruments used were video game videos and forms. Elements for recording are shot for two points (failure 2 -), shot for three points (failure 3 -), free throws (faux 1,2,3, -), turnovers (t), etc. for a foul throw (F), a foul up bonus (f), rebound (2, +,-). European games are usually used 11 such forms and the U.S. about 16 games, the quarter three or four. After the match, the results are summarized in aggregate form, which are added all the variations of horizontal and have a complete insight into the flow of the match against the given tactical variants, in each quarter of the total. Tactical elements that were observed in: a player translate the ball over the fields and send a shot without adding (1), sometimes break the first line and then send a shot (2), break the first line and pass the ball to teammate for a shot (to Americans often work without punching - shot after the first pass) (3), when a teammate fails to send a shot after the first addition, but still pass the ball (4), but still listed separately according to input and feedback from system attacks the ball and then usually sends a shot (5), when players in team running out for the attack, send a shot of what may happen (6), the player translate the ball across the pitch and goes to the door and laid the ball (7), systematic variations of the free space to enter any of the players (8) , teams play to the assistance and it is solely the result of teamwork (9), waiting for the completion of system conditions and pivoting (10), free throws (11), after a stoppage of play during the performance of the ball with the free kick is sent (12), when a player translating the ball across the pitch to lose the ball (13), the pressing is not easy to get the ball and set up the game (14), rebound is verified through caught the ball and credit points (15) and at the end of the counter (16). The method of data processing is in SPSS 11.5. Descriptive statistics were processed by the coefficient, the arithmetic mean, average and sum the results.

Results and discussion

We presented two theoretical models of balance: a balance that shows the spatial distribution of the concepts of attack, whether the attack was completed in the field or directly under the basket and personal team balance that shows the distribution of individual and team attack. Basketball game lasts 10 minutes per quarter or 600 seconds. Team attack allowed 24 seconds which means that during the whole game can be done 100 attacks, or 50 for each team. The most common number of attacks in European games is around 70. In total, the game takes 2400 seconds divided by 140 attacks each team receives an average time of the attack of 17.1 seconds. American basketball is 12 minutes and a total time of the game is 2880 seconds divided by 200 attacks each team receives an average of 14.4 attacks during the second. On the spatial form ''balance'' the option ''t'' we see the EU theoretical model 70 variant attacks. From the mentioned 16 separate variants are those that are the result of planning activities, while others are the result of situational moment. Explanation of a given number of attacks by variants in relation to the number of players and the logic of the position: solo shot (3 combinations) belongs to the person who takes the ball across the pitch, so it is logical that it be play, quarterback and possibly wing, punching a shot (5 combinations), is performed when the ball is already in the opponents' half and can be associated to each player, adding a punch shot (6 combinations), if the centers performed no reason to punch the ball so that it applies to play, and wing-back. Each of them can add the other two, so that the number of combinations are 6, system shot have 25 combination, five players on the five positions of 25 features, thesystem entry reverse shot have 3 combination, return the ball to return to the field as belonging to the three players, forced a shot (0), is the result of situational moment, not planned activities so that it is not referenced here, but it appears in reality, single input (5 combinations), five players and anyone can enter the system in (5 combinations), also plays for the entry system of each player, assists (6 combinations), assists the usually centers, which means that each of the three players make the ball penetrating the centers, which total 6 pivot system (8 combinations), four players added to the center pivot. Given that the game and the two centers, a total of eight possibilities. Contra (4 combinations) the logic of the four players were able to counter attack. When we add all these variants we get 70 of planning attacks. The blue fields of the attacks from the zone of rubble and there's 42. The yellow boxes are the attacks that realzed under the basket and has them 28. Therefore, this theoretical model and is called the spatial balance and relationship is shown by the coefficient which is 0.67. In the event that has 80 attack of the match ratio remains the same, but the number of varieties changes. In Table 1. personally team balance we see that the prevailing view in the game or team or individual action is balanced by a given theoretical model. The same variants of the attack as the spatial balance, only arranged differently and see that the ratio has a slight deviation (from 0:47 - 0.50), mean 0.48. Spatial balance coefficient was 0.67. Personnel team balance coefficient was 0.48.

Now let's see specific games: NBA, native and the Adriatic League Final Four and the 2009 year. Spatial balance tells us from which the position is carried out the attack. NBA based on 3 games has coefficient 0.76. The ratio of attacks under the basket and from a field of 43: 57 According to theoretical model ratio is 40: 60 NLB league and Final four coefficient is 0.94, ie. 33 attacks under the basket, and 37 attacks from the field, which is pretty balanced. According to theoretical model ratio 28:42 Final four in Berlin in 2009, on the basis of three games coefficient is 1:08, ie. 33 attacks under the basket, and 29 from the field, which indicates that they are less kicking and more the racket. Basketball club Partizan run through five games has coefficient 0.93, ie an average of 31 attacks under the basket and 34 attacks from the field. CSK run through five games has coefficient 0.64, ie an average of 22 attacks under the basket and 35 attacks from the field. LA Lakers' run through three games have coefficient 0.94, ie an average of 50 attacks under the basket and 53 from the field. Personnel team balance tells us about the balance of individual and team activities. NBA teams based on 3 games has coefficient 0.32. Ratio of solo and team work is 24:76. According to theoretical model ratio is 32:68, ie. coefficient 0.48. NLB league and the Final four coefficient is 0.21, ie. ratio of solo and team work is 12:58. According to theoretical model ratio 23: 47, ie. coefficient 0.48. Final four in Berlin in 2009, on the basis of three games coefficient is 0.19, i.e.ratio of solo and team works are 11:56, which tells us that the prevailing team action. Partizan run through five games has coefficient 0.18, ratio of solo and team work is 11: 60, which in this case we say that the prevailing team action. CSK run through five games has coefficient 0.15, the ratio of solo and team work is 9:57, which tells us about convincing the prevalence of team action. LA Lakers run through three games have coefficient 0.29. Ratio of solo and team work is 23: 80 by theoretical model is 32:68. Totally for physical balance, which determines the implementation of the attack from the point position on the field, we see that in all leagues similar ratios (about 0.90), compared to the teams, only the approximate CSK theoretical model, while other high coefficients which means that the number of attacks carried out under the basket but the field, seen in relation to theoretical model. The focus in the implementation, was moved to the lead and the system entry, assists, pivoting and conditional counters. Totally for personal team balance, which determines the individual and team commitment, we see that the NBA has a coefficient, and league and team around 0.30, while the European teams have coefficient around 0.20 (CSK 0.15), which means that more Americans take on individual characteristics of players in the motor and especially in the psychological sense, while the European basketball is still under great pressure planned action, without much room for improvisation, which impressively demonstrates the CSK. On Table 3. we see the results match the Lakers - Cleveland 105:88. It is noticed that the Lakers as either (a shot), though they gave the same number of points (49), which is a better percentage terms, meaning that they had fewer misses ie. were effective. The variants (enter) we see a drastic difference in favor of the Lakers, 20 points higher, and in terms of percentages 93 to 56. The leap and counters are similar. The free throw percentage on the side of Cleveland, but in absolute terms this is no big difference, 11 for 6.

Table 1. Personal and spatial balance

TEAM	Personal balance		Spatial balance	
	Kf	0.47-0.5	Kf	0.67
NBA	24	76	57	43
	100	0,32	100	0,76
BERLIN F 4	11	56	29	33
	67	0,19	67	1,08
NLB	12	58	37	33
	70	0,22	70	0.93
PARTIZAN	11	60	34	31
	71	0,18	71	0,93
CSK	9	57	35	22
	66	0,15	68	0.64
EU	10,7	57,8	33,7	29,7
		0,2		0,9

Table 2. Solo/team balance

SOLO/TEAM	**EU**			**EU I**			**EU II**			**NBA III**			**NBA IV**		
single shot	5	8		5	8		5	9		6	10		6	11	
punch shot	3			3			4			4			5		
solo entry	4	4	20	5	5	23	6	6	26	7	7	29	7	7	32
add punch shot	4	4		6	6		7	7		8	8		9	9	
contra	4	4		4	4		4	4		4	4		5	5	
system entry	4	9		5	11		6	13		7	15		8	17	
system assis.	5			6			7			8			9		
system shot	2	24		25	28	47	28	32	54	31	36	61	34	40	68
feedback sys shot	2	5	40	3	6		4	7		5	8		6	9	
system pivot	7	7		8	8		9	9		10	10		11	11	
∑-num. of attacs	6	60	60	70	70	70	80	80	80	90	90	90	100	100	100
Balance S/C	0.5			0.49			0.48			0.48			0.47		

Table 3. Aggregate comparison

TEAM		Lakers		Cleveland		Partizan		Cibona		Panat.		Olimp.	
Shot	prec.	20	40	21	36,2	9	21,9	8	25	8	40	7	27
	∑	49	98	49	84,5	22	53	22	68,8	23	115	20	77
Entry	prec.	19	46	9	28,1	10	43	7	20	18	41	19	43
	∑	38	93	18	56,3	20	87	14	40	36	82	38	86
Contra	prec.	3 for 6		1 for 2		2 for 2		2 for 4		1		1 for 2	
	∑	9		2		4		4		2		2	
Jump	prec.	1		2		1		1		2		1	
	∑	2		4		2		2		4		2	
Free shot		42,8		57,9		68,1		40,0		85, 71		68,0	
∑ I – (loss balls)		47		56		40		51		28		34	
∑ A (num.of att)		99		100		73		77		68		76	
∑ I		47,47		56		54,79		66,23		41,18		44,74	
A													
R	prec.	48		40		40,4		27,9		56,62		50,0	
A	∑	106		88		86,3		64.6		123,53		107,89	
∑ R		47,5		40		29,5		21,5		38,5		38	
∑ of points		**105**		**88**		**63**		**49**		**84**		**82**	
Personal balance	coef.	25	98	30	92	8	70	26	72	13	68	9	70
	0.47	73	0,34	62	0,48	62	0,13	46	0,57	55	0,24	61	0,15
Spatial balance	coef.0.67	48	98	58	92	42	70	33	72	25	68	26	70
		50	1,04	34	0,59	28	0,67	39	1.2	43	1,72	44	1,69
Effects		69,1		64,1		69,24		47,19		92,06		74,82	

Table 4. Comparative balance

SOLO/TEAM	**EU**			**EU I**			**EU II**			**NBA III**			**NBA IV**		
single shot	5	8		3	8	42	5	9	48	6	10	54	6	11	60
punch shot	3			5			4			4			5		
add punch s	4	4		6	6		7	7		8	8		9	9	
system shot	2	2	36	25	25		28	28		31	31		34	34	
feedback sys shot	2	2		3	3		4	4		5	5		6	6	
extracte shot															
single entry	4	8		5	10	28	6	12	32	7	14	36	7	15	40
system entry	4			5			6			7			8		
system assistance	5	5	24	6	6		7	7		8	8		9	9	
system pivot	7	7		8	8		9	9		10	10		11	11	
contra	4	4		4	4		4	4		4	4		5	5	
∑ -num. of attacs	6	6	60	70	70	70	80	80	80	90	90	90	100	100	100
Balance C/Š	0.67			0.67			0.67			0.67			0.67		

The Lakers have had fewer misses and turnovers in 47 to 56, and the activity had about the same 99 and 100, which resulted in the same proportion. Release the accuracy and efficiency in the Lakers' side, 48/40 and 106/88. The Lakers are 47.5 threw the ball through the basket, and the 40. Cleveland personal team balance by theoretical model and the Lakers coefficient 0.34, indicating that they had prevailed on team actions, viewed in relation to theoretical model. Cleveland is closer to the theoretical model and physical balance, while the Lakers to move coefficient 1.04 tactical variants with shot variants position under the basket (pivoting, the system entry, etc.). The Lakers have played a tactical attacks through the team's options (enter), and Cleveland although with a fairly balanced game, fell short in accuracy and concentration. They have a large percentage of turnovers and mistakes.

On the basis of six NBA teams (Table 4.) shows that the ratio of team balance personal 0.32, and spatial balance of 0.76. In relation to the theoretical model we see deviation and dominance, team activities, and variants of attacks that are based on area under the basket. However, when you look at European teams, we see that they are even more moved to a team activity, and variants of the attack.

In a relative comparison, we see that the U.S. basketball more than the European, oriented to quality and intraindividual expression are distributed in the area of the field so that again closer theoretical model of the European, which means that more attention to rubble, while the European teams pay more attention combinatorics under the basket.

Conclusion

Established the parameters for analysis. Based on observations at all levels of game it was up to 16 items that are recorded in summary form, and 11 items logged in the application forms for the balance. Based on the established parameters, appearing in all leagues, formed the theoretical model, which indicates the distribution of team work and physical activity.

Based on average results of coefficients of balance, compared to American and European concept of the game, showing us the differences in approach to tactical action. American basketball is faster than Europe for 3 to 4 seconds, looking at the average time of the attack, which is reflected in the coefficient personal team balance, which is 0.32 in the NBA and in Europe 0.2. On the basis of comparative form, where the statistical parameters from the combined and balancing form, it is possible to realize the essential characteristics of the team and compare the winner and loser. On the soles of tracking multiple games can gain insight into the concept of a team attack. Do you prefer more team or individual activities, and speaking through a balanced form, it can be determined by the average value per item. How one team has a pivoting attacks, assists, antagonism, etc. Based on the monitoring of a team it is possible that are weak or good by the attack and subsequently corrected by training and tactical tasks.

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STATISTIČKA ANALIZA TAKTIČKIH ELEMENATA U KOŠARKAŠKOJ IGRI

Sažetak

Predmet istraživanja je analiza košarkaških utakmica i to sagledavanje taktičkih elemenata, njihova učestalost i efikasnost. Problem je statistička obrada taktičkih elemenata. Cilj istraživanja je da se ustanovi teorijski model kao orijentir za taktičku pripremu koja će rezultirati boljom efikasnošću. Zadatak istraživanja je da se formularom uspješno prate i analiziraju košarkaške utakmice u taktičkom pogledu. Metode istraživanja se dijeli na: uzorak varijabli: solo šut, probijanje šut, probijanje dodavanje šut, sistem šut, sistem ulaz povratna, iznuđen šut, solo ulaz, sistem ulaz, sistem asistencija, sistem pivot, slobodno bacanje, prekid šut, prevođenje, prekid igra, skok, kontra. Eksperimentalni tretman podrazumijeva izdvajanje elemenata putem promatranja utakmica domaće lige, Final four do NBA. Obrada podataka je izvršena u paketu SPSS-11.5. Deskriptivnom statistikom se obrađuje koeficijent, aritmetička sredina, prosjek i suma rezultata. Rezultat istraživanja: prikazana su dva teorijska modela balansa i to prostorni balans koji pokazuje distribuciju koncepata napada, je li napad završen iz polja ili neposredno pod košem i personalno timski balans koji pokazuje distribuciju individualnog i timskog napada. Zaključak: uspostavljeni su parametri za taktičku analizu utakmica. Na osnovu promatranja utakmica svih nivoa došlo se do 16 stavki koje se bilježe u zbirne formulare, a 11 stavki se bilježi u formulare za balans. Na osnovu ustanovljenih 11 parametara igre, koji se pojavljuju u svim utakmicama, formiran je model, koji nam ukazuje na raspodjelu timskog i prostornog djelovanja.

Ključne riječi: *košarka, taktika, elementi, analiza*

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DEVELOPMENT ATTITUDE CHARACTERISTICS ABOUT LEISURE TIME OF GRAMMAR SCHOOL FEMALE STUDENTS

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Original scientific paper

Abstract

The research was conducted on the sample of 647 female students in Grammar school described with 25 indicators of leisure in fitness. Data were prepared according to factor model for latent dimensionality determination, and SDA discriminative analysis was applied on 4 age rates in high school for development validity determination. Methodological, the research belongs to explorative procedure, and the aim is to determine validity of system value formation. The results indicate there are three processes that occur parallel in one part of examinees: a) constructive cognition process, b) destructive inactivity process and c) oscillatory process of multiple activation attempts. Such information are directly applicable for the purpose of planning, programming and conducting fitness in daily practice because they give answers to basic cause questions which form common values and certainly values regarding leisure time.

Key words*: leisure time, development, high school girls*

Introduction

Many leisure time definitions can be found in existing literature, all but ones that claim there is no leisure time. However, the closest to the actual conditions is cognition that leisure time is the time of totally available time in one man's life that he doesn't sense as an obligation and dedicates to it by his free choice. That is the space in daily (weekly, annual…) schedule of individual when the one is primarily spared from work and other obligations that came out of parental, children, brothers, association and other social relations. (Bilić & Bonacin, 2007). However, leisure time is always a concept of a special interest and not only to discover its nature in different causes and populations, but to find adequate solutions so possible issues in leisure time could be corrected and eliminated. Such actions require familiarizing with leisure time that can be recognized in some acceptable way. That is possible through large diapason of means, but for start the simplest is to ask individuals how they see that leisure time in their personal example. This becomes interesting when we talk about female samples. That is because such research is a lot less conducted then with male samples and it is the case with age rates, because social-kinesiology research are usually located into samples that have stabile sociometric and other position, which means adults. (Petrović & Hošek, 1986). Although, in such way we are deprived from valuable information that testify about development of future citizen abilities, as well as of actual supposition of development age that will become „grown - ups" in upcoming years (Bonacin, Da., 2009). As it is known, some ages doesn't have to have acceptable and wanted attitude and opinion for us. Some of this age samples are high school boys and girls, since that is the age when many changes occur because of growing up and some of this changes have their repercussions into sociological life sphere that can not and shouldn't be ignored. Finally, in that age we can recognise how succesfull in some areas were our efforts to support formation of quality value systems in previous educational intervals. Certainly, rough development in age of 15 to 19, when the girl tends to form permanent values according to many sociological values, leisure time as well, but that development is not simple in this age period. (Bilić, 2009).

Problem and aim

Problem of this research is therefore set of social system elements towards leisure time in the way how treated entities experience it. The subject of this research are girls from 15 to 19 years of age, in other words high school girls from Grammar school, their attitudes toward leisure time within the meaning of available resources, offered schedules, the way how they spend their resting time, cognitions and knowledge about organizing leisure time and the meaning of recreation during leisure time. The aim of this work is to identify development attributes in different age, apropos from first to fourth grade of Grammar school.

Methods

For this research we selected the sample of 647 Grammar school female students in Herzegovina, age 15 to 19. Totally there were 167 first grades, 158 second grade, 166 third grade and 156 forth grade students. The examinees were described with 60 indicators of leisure time. The author of the survey was Danijela Bonacin (Bonacin, Da., 2009) These indicators were reduced to 25 indicators after normalization of multivariate procedure Iterim (Bonacin, 2007) and they all have maximal mutual variability.

Such prepared data of the total sample were subject to elementary statistic processing and standard factorization procedure with skew in oblique Orthoblique position (Bonacin, 2004) for obtaining basic information on latent dimensions which is structure of applied indicators. After that we performed ANOVA and SDA discriminative analysis (Bonacin, 2004) to obtain information on chronological differences according to sub-samples, apropos basically - development characteristics of Grammar school female students within chosen set of variables.

Results and discussion

Based on centroid groups it is obvious that the first discrimination function differentiate girls The results of this research indicated there are evident differences in univariate area (ANOVA) Set of orthoblique factor total (table 1) describes 5 very clear latent dimensions: 1) *socially driven usage of leisure time* 2) *educationally driven usage of leisure time* 3) *work dependable usage of leisure time* 4) *personally driven usage of leisure time* and 5) *organized management of leisure time*. In such way we identified Grammar school female student leisure time indicators and potential recreational activation. between girls according to their age within defined set of variables (table 2) This variations are obvious through whole series of all 15 indicators. It seems that age has a large impact on formed opinions about leisure time.

It is so obvious that almost all minimal indicator values exactly in the first two grades of high school and the fourth grade has not even one minimal, but series of maximal values. In factor perspective, girls in fourth grade express the most their values in latent dimension of organized management of leisure time. The girls in first grade have the lowest values in three latent dimensions: social, educational and organizational management of leisure time. It seems that first grade girls have certain level of parental control and other system values from previous periods. In second grades, because of sociological changes and more independence that value fades away and is replaced with own attitudes and social exposition, but it is not adequately established.

This kind of situation is developed through third grades and in fourth grade we have newly formed cognitions that we can optimistically specify as positive. Development characteristics are easily recognized and describe social and comprehensive development meaning options and possibilities of leisure time management generally. Discriminative SDA analysis discovered three significant discrepancy functions between chronologically defined samples of girls with 51.67 %, 40.47 % i 7.86 % clarified total variations. Eigen values were 0.80, 0.63 i 0.12, and canonic correlation 0.90, 0.79 and 0.35, so the conclusion is there are three ways to differ the samples.

Table 1. Orthoblique position of leisure indicators and factor correlations of total sample

Varijable	OB1	OB2	OB3	OB4	OB5
For recreation we should use all nature resources according to	0.55	0.19	-0.08	0.14	0.17
It is neccesary to make specific programs in coordination with society	0.87	-0.03	0.06	0.01	0.01
The society has to provide funds for recreation purposes during leisure time.	0.55	0.30	-0.09	0.11	-0.07
I am familiar with many various recreation activities	0.82	-0.05	0.14	0.08	0.01
Many that I know are involved in sports activities in leisure time	0.80	0.14	0.03	-0.02	-0.10
Educated people schedule their leisure time better	0.27	0.65	-0.01	0.13	0.00
Recreation in leisure time contributes to health	0.16	0.74	-0.03	0.01	0.04
There are better way than sports to fulfill your leisure time	-0.54	0.76	0.11	0.11	0.06
Individual programs should be created	0.01	0.72	0.08	-0.06	0.12
New courts, halls and other facilities should be built.	0.15	0.85	-0.11	-0.14	0.01
Who don't sleep well cannot perform their job well	-0.06	-0.09	0.88	-0.03	0.08
I sleep in may leisure time	0.25	0.02	0.85	-0.12	-0.02
I study just as much as its needed	0.09	-0.01	0.84	0.12	-0.14
I am capable of managing my leisure time	-0.47	0.14	0.51	0.10	0.29
Wellness is a great way of spending your leisure time	-0.22	0.03	0.29	0.10	0.50
More knowledge enables more leisure time	0.19	0.14	0.13	0.63	-0.06
I have great responsibilities and have no leisure time	0.07	-0.54	-0.14	0.87	0.25
I always find some free time for myself	-0.26	-0.18	0.09	0.87	-0.04
Resting means take some time and recover	0.31	0.34	0.16	0.36	-0.24
I have to exercise more in my leisure time	0.18	0.11	-0.19	0.62	0.09
I regularly have my physical and take advices on exercising	-0.05	0.16	-0.07	0.07	0.78
Body activity makes miracles for psychophysical recovery	-0.33	0.43	-0.17	0.19	0.47
I spend my holidays with my family and friends	-0.16	0.32	0.04	0.10	0.61
I participate and follow competitions	0.36	-0.35	0.18	-0.26	0.82
With my friends I play some indoor soccer, basket etc	0.36	-0.28	-0.19	-0.20	0.91
	OB1	OB2	OB3	OB4	OB5
OB1	1	0.28	0.05	0.31	0.15
OB2		1	0.03	0.34	0.44
OB3			1	0.17	0.22
OB4				1	0.16

(OB1,2,3,4,5 = orthoblique skew factors position)

Table 2. Descriptive statistics (Min = 1, Max = 5)

Variables	CL1	CL2	CL3	CL4	TOT	SD	P
For recreation we should use all nature resources according to	3.78	3.59	3.74	3.94	3.76	0.98	0.02
It is neccesary to make specific programs in coordination with society	3.30	2.98	3.28	3.50	3.26	1.10	0.00
The society has to provide funds for recreation purposes during leisure	3.57	3.58	3.80	3.89	3.71	0.91	0.00
I am familiar with many various recreation activities	3.30	3.13	3.27	3.39	3.27	0.96	0.10
Many that I know are involved in sports activities in leisure time	3.43	3.39	3.58	3.58	3.49	0.98	0.17
Educated people schedule their leisure time better	4.25	4.21	4.43	4.50	4.34	0.78	0.00
Recreation in leisure time contributes to health	4.37	4.26	4.60	4.55	4.45	0.72	0.00
There are better way than sports to fulfill your leisure time	3.95	4.16	4.27	4.17	4.14	0.85	0.01
Individual programs should be created	4.26	4.21	4.46	4.26	4.30	0.85	0.04
New courts, halls and other facilities should be built.	4.31	4.34	4.53	4.47	4.41	0.70	0.01
Who don't sleep well cannot perform their job well	3.05	2.72	2.59	2.66	2.76	1.31	0.01
I sleep in may leisure time	3.47	3.25	3.18	3.19	3.28	1.08	0.05
I study just as much as its needed	2.23	2.17	2.05	2.20	2.16	1.17	0.51
I am capable of managing my leisure time	3.27	3.14	3.22	3.25	3.22	1.15	0.76
Wellness is a great way of spending your leisure time	3.90	3.63	3.70	3.79	3.76	1.06	0.13
More knowledge enables more leisure time	3.93	3.89	3.98	4.00	3.95	1.00	0.76
I have great responsibilities and have no leisure time	3.34	3.18	2.88	3.26	3.16	1.32	0.01
I always find some free time for myself	3.47	3.56	3.38	3.59	3.50	1.20	0.39
Resting means take some time and recover	3.10	3.17	3.46	3.55	3.32	1.09	0.00
I have to exercise more in my leisure time	4.06	3.97	4.05	4.28	4.09	0.97	0.04
I regularly have my physical and take advices on exercising	3.90	3.65	3.75	3.80	3.78	1.06	0.18
Body activity makes miracles for psychophysical recovery	4.35	4.51	4.51	4.45	4.46	0.87	0.33
I spend my holidays with my family and friends	3.89	3.82	3.89	3.85	3.86	1.37	0.96
I participate and follow competitions	2.86	2.18	2.31	2.60	2.49	1.30	0.00
With my friends I play some indoor soccer, basket etc	3.20	2.69	2.87	3.05	2.96	1.18	0.00

(CL1,2,3,4 = means for each class, TOT= mean for total, SD = total standard deviations, P = probability of ANOVA)

Table 3. SDA discriminative functions of 4 girl groups (classes)

Variable	DF1	DF2	DF3
For recreation we should use all nature resources according to	0.55	-0.35	-0.13
It is neccesary to make specific programs in coordination with society	0.47	-0.44	-0.22
The society has to provide funds for recreation purposes during leisure	0.70	-0.06	-0.20
I am familiar with many various recreation activities	0.41	-0.47	-0.20
Many that I know are involved in sports activities in leisure time	0.55	-0.25	-0.13
Educated people schedule their leisure time better	0.79	-0.04	0.05
Recreation in leisure time contributes to health	0.78	0.04	0.27
There are better way than sports to fulfill your leisure time	0.44	0.31	0.28
Individual programs should be created	0.58	0.02	0.46
New courts, halls and other facilities should be built.	0.79	0.18	0.33
Who don't sleep well cannot perform their job well	-0.39	-0.57	0.14
I sleep in may leisure time	-0.19	-0.59	0.11
I study just as much as its needed	-0.17	-0.48	-0.10
I am capable of managing my leisure time	-0.13	-0.21	0.24
Wellness is a great way of spending your leisure time	-0.05	-0.40	0.25
More knowledge enables more leisure time	0.45	-0.21	-0.33
I have great responsibilities and have no leisure time	-0.01	-0.41	-0.62
I always find some free time for myself	0.07	-0.10	-0.61
Resting means take some time and recover	0.64	-0.05	-0.33
I have to exercise more in my leisure time	0.54	-0.14	-0.42
I regularly have my physical and take advices on exercising	0.30	-0.34	0.33
Body activity makes miracles for psychophysical recovery	0.40	0.10	0.24
I spend my holidays with my family and friends	0.34	-0.21	0.30
I participate and follow competitions	-0.17	-0.81	0.37
With my friends I play some indoor soccer, basket etc	0.06	-0.63	0.29
	DF1	DF2	DF3
CL1	-0.10	-0.14	0.03
CL2	-0.12	0.11	-0.03
CL3	0.10	0.08	0.06
CL4	0.12	-0.05	-0.05

(DF1,2,3 = discriminative functions, CL1,2,3,4 = centroids of school classes)

The first two are extremely important and the third one is less important. According to the level of education because extremely better values are found in girls in third and fourth grades. This is especially the case with social and educational fields but also in leisure time personally managed. On the contrary there is work dependable leisure time that describes girls in first two grades when probably their obligations increased regarding previous period.

First function explains ***development cognitions about leisure time,*** that increase regarding education duration. And here we have constructive process. Second discrimination function indicates that after first function there is still a large number of variations 40% that cannot be explained with education level, but in some other way. Centroids refer us to the difference between second, third and especially first grades and a little bit less between second and third and the fourth grades. It is obvious that the girls in the first grades feel a lot less conditioned lack of recreation leisure time, but they are involved in certain activities, and the girls in second and third grades show deviation in personal participation in physical activities of organized leisure time as well as general content knowledge. On a positive side (second and third grades) is minor number of indicators but they are aimed toward other activities and social community critics.

This is how this function explains phenomenon of ***inactivity and abandon to passive forms*** in leisure time and it certainly is generally destructive process. It is obvious that in second grade we have very specific set of actions that completely change girl's sociological texture, which can be connected to their age but not to becoming mature. It seems there is a change in one part of value system that doesn't have to be justified.

Finally, third discrimination function indicates differences between first and third, from second and fourth grades in Grammar school and so points out very unusual character. Essentially it brings first graders and second graders into connection through organized and educationally driven leisure time management and on the other side social and personally managed leisure time that is specific for the second and fourth graders.

This kind of position of discriminative function obviously describes appearance of ***multiple attempts of activation in leisure time*** so it results as one oscillatory process. The results pointed that complexity of girls development is large and this problem can not be approached in a trivial way (*Bilić i sur., 2009*).

Conclusion

Leisure time as a basic assumption for personal activation of young high school girls in kinesiology recreation would be a basic subject of this research. The aim of the research would be determining validity of development attributes through four age categories of female students 15 to 19 years of age.

For this work purposes, 647 girls were described with 25 leisure time indicators and the data were processed by standard univariate (descriptive statistics, ANOVA) and multivariate (Ortholique factor rotation, SDA discriminative analysis) methods. The results crystallized into three processes that the girls go through a) development cognitions about leisure time b) inactivity and abandon to passive forms and c) multiple attempts of activation during leisure time. It is assumed that careful and more precise approach to high school girl's phenomena is needed, especially with forming of value system.

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ZNAČAJKE RAZVOJNIH STAVOVA O SLOBODNOM VREMENU UČENICA GIMNAZIJA

Sažetak

Provedeno je istraživanje na 647 učenica gimnazije opisanih sa 25 indikatora slobodnog vremena u rekreaciji. Podaci su pripremljeni i obrađeni u skladu s faktorskim modelom radi utvrđivanja latentne dimenzionalnosti, a primjenjena je i SDA diskriminativna analiza po 4 uzrasta srednje škole radi utvrđivanja razvojnih zakonitosti. Metodološki, istraživanje pripada eksplorativnoj proceduri, a cilj je utvrđivanje zakonitosti formiranja sustava vrijednosti. Razultati su pokazali da postoje tri procesa koji se odigravaju paralelno kod dijela ispitanica: a) konstruktivni spoznajni process, b) destruktivni proces inaktiviteta, i c) oscilatorni proces višestrukih pokušaja aktivacije. Ovakve informacije direktno su primjenjive u svrhu planiranja, programiranja i provedbe rekreacijskih sadržaja u svakodnevnoj praksi jer daju odgovore na temeljna pitanja uzroka koji dovode do formiranja općih vrijednosti a svakako i vrijednosti vezane uz slobodno vrijeme.

***Ključne riječi**: slobodno vrijeme, razvoj, srednjoškolke*

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DIFFERENCES IN SPEED AND FUNCTIONAL ABILITIES BETWEEN FOOTBALL PLAYERS OF THE FIRST AND THE SECOND LEAGUE

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Original scientific paper

Abstract

The aim of this study was to determine the differences in speed and functional abilities of football players of the first and the second league. The sample of respondents included in this study, consisted of the players of the first and the second Serbian League (22 players of the first and 18 players of the second football league). The sample of variables consisted of three variables to assess the speed and functional abilities of players (maximum running speed between cones at 20 meters, maximum running speed on the track, the operating speed, maximum oxygen consumption, hearth rate at rest and at the end of the test). The authors conclude that there are statistically no significant differences in the speed between players of the first and the second football league at the multivariable level, as well as in the maximum running speed on the track. However, there are significant differences in the maximum running speed between the cones at 20 meters, as well as the operating speed. Statistically, there are also no significant differences in the functional abilities at multivariable level between the players of the first and the second football division, as well as in the heart rate at rest and at the end of the test. Statistically, significant differences exist only in maximum oxygen consumption between the players of the first and the second football league.

Key words*: soccer players, first and second league, speed, functional abilities, differences*

Introduction

Today, football is the most popular sport, played by all nations without exception, of both sexes and various ages, regardless of skill level (Stølen et al., 2005). However, to achieve top results in this sport it is essential that players have a considerable level of technical and tactical skills and significant physical condition (Svensson & Drust, 2005). When it comes to physical condition, in the game such as football, it has a wide range of individual characteristics and it is composed of numerous motor, physiological, psychomotor, and psychological factors (Ostojić, 2006).

Their high level is required throughout the competition so that players could respond to all the requests that a football game demands. Also, players must have a highly developed functional ability and desired body structure (Al-Hazzaa et al., 2001; Aziz et al, 2000; Reilly, 2005; Vujović & Veljović, 2010). Identification and development of young football players have become very important for most top teams (Williams and Reilly, 2000). Numerous variables are taken into account when it comes to choosing the best young football players, and they all are assessed with the help of numerous laboratory and field test procedures. In spite of the fact that the importance of testing is reflected in evaluation of anthropological characteristics and estimation of the efficiency of training process, probably the most important task is selection of the constant monitoring of youth development and the quotation of these categories of football players in the longer period of time (Stojanović, 2008).

Reilly, Williams, Neville and Franks (2000) argue that the demands of football game are multifactorial and that the distinguishing characteristics of top players may be tested using multivariable analysis. The aim of this work is to use comprehensive tests on young players in order to distinguish between elite and sub-elite groups on the basis of the performance on the test. Thirty-one (16 elite, 15 sub-elite) young players, paired chronologically by age (15-16 years) and body size, participated in the study. Test items included anthropometric (N = 15), physiological (N = 8), psychological (N = 3) and specific football skills (N = 2). The variables were divided into special groups according to body composition, body size, speed, endurance, performance measures, technical skill, anticipation, anxiety, task and ego orientation for the multivariable analysis and gradual - analysis of discriminate function. The biggest differences were in the measurement of agility, sprint time, ego orientation and the expected skills. Elite players also possessed more aerobic power (9.0 ± 1.7 vs. 55.5 ± 3.8 ml • kg-1 • min-1) and were more tolerant to fatigue ($p < 0.05$). Also, they were better at running for a ball, but not at kicking at the goal. We conclude that using battery of tests may be useful for establishing the basic reference data for young football players who are going to be selected for specialized programs of development. Helgerud, Engen, Wisløff & Hoff (2001) aimed to study the effects of aerobic training on the results during football match and the specific football tests. Nineteen male football players of younger elite categories, age 18.1 ± 0.8 yr, randomly assigned to the training (N = 9) and control group (N = 10), participated in the study.

The specific aerobic training consisted of interval training, four times 4 minutes at 90-95% maximum heart rate, with 3-minute jogging in between, two times a week for 8 weeks. Players were monitored by video during the two games, one time before and one time after training. The results show that in the training group a) maximal oxygen consumption (Vo_{2max}) increased from 58.1 ± 4.5 mL • kg-1 • min-1 to 64.3 ± 3.9 mL • kg-1 • min-1 (P <0.01); b), limit of lactate improved from 47.8 ± 5.3 mL • kg-1 • min-1 to 55.4 ± 4.1 mL • kg-1 • min-1 (P <0.01), c), the economy of running also improved by 6.7% (P <0.01), d), distance covered during the match increased by 20% in the training group (P <0.01), e), the number of sprints increased by 100% (P <0.01), f) number of contacts with the ball increased by 24% (P <0.01), g), the average work intensity during the football match, measured as a percentage of maximum heart rate, improved from 82.7 ± 3.4% to 85.6 ± 3.1% (P <0.01); h) and no changes were found in the maximum height of vertical jump, strength, speed, speed of hitting, kicking precision, or quality of passing after the training period. The control group showed no changes in any of the tested parameters. The authors have concluded that the improved aerobic endurance at football players increases football performance by enlarging the covered distance, the intensity of work, as well as the number of sprints and contacts with ball during the match. Mohr, Krustrup & Bangsbo (2003) aimed to assess physical fitness, match performance and development of fatigue during matches on the two high standards of professional football. Computerized analysis of time trends was performed 2-7 times during the competition season on the 18 top and 24 moderate professional football players. Besides that, the players performed the Yo-Yo occasional recovery test. The top players performed 28 and 58% more (p <0.05) high-intensity running and sprints, respectively, than the moderate players (2.43 ± 0.14 vs. 1.90 ± 0.12 km and 0.65 ± 0, 06 vs. 0.41 ± 0.03 km, respectively). Many top players were better (11%, p <0.05) for the Yo-Yo periodic recovery tests than the moderate players (2.26 ± 0.08 vs. 2.04 ± 0.06 km, respectively). The amount of high intensity running, independently of competitive standard and player's position, was significantly lower (35-45%, p <0.05) in the last minutes than in the first 15 minutes of play. After a period of 5 minutes, during which the amount of highly intense running reached the peak, the performance was reduced (p <0.05) by 12% over the next 5 minutes compared to the average game. The replaced players (N = 13) covered 25% (p <0.05) of ground for 15 minutes of the final high-intensity running than the other players. The coefficient of variation in high-intensity running was 9.2% between the successive matches, while it was 24.8% at different stages of the season. The total covered distance and distance covered in high-intensity running were higher (p <0.05) at the midfielders, guards and attackers than at the defenders. The attackers and backs covered a greater (p <0.05) distance in sprinting than the players in the midfield and defence. The midfielders and backs covered a greater (p <0.05) distance than the attackers and defenders in the Yo-Yo periodic recovery tests (2.23 ± 0.10 and 2.21 ± 0.04 vs. 1.99 ± 0.11 and 1.91 ± 0.12 km, respectively). The results showed that: (1)the top players showed more high-intensity running during the match and were better in the Yo-Yo tests than the moderate professional players, (2) fatigue occurred at the end of the match, and temporarily during the game, regardless of the competition standards and positions in the team, (3)the defensive players covered shorter distances at high-intensity running than the players who played on the other positions, (4the defenders and attackers had a poorer performance on the Yo-Yo intermittent recovery test than the midfielders and backs, and (5) considerable seasonal changes were recorded in physical performance during matches.

McMillan, Helgerud & Hoff (2005) aimed at the researching of physiological adaptation during the 10 weeks of high-intense aerobic interval training program performed by young professional football players, following a certain soccer ball path. Eleven young footballers of the average age of 16.9 (0.4) years, conducted high-intensity aerobic interval training twice a week for 10 weeks with regular football training. The specific aerobic training consisted of four sets of 4 minute period of keeping the soccer ball around a specially designed path at 90-95% maximum heart rate, with 3 minutes of jogging for recovery to 70% of maximal heart frequency between intervals. Medium Vo_{2max} was significantly improved from 63.4 (5.6) to 69.8 (6.6) ml kg-1 min-1, or 183.3 (13.2) to 201.5 (16.2) ml kg-0.75 min-1 (p <0.001). Squat jump and counter jump height was significantly improved from 37.7 (6.2) to 40.3 (6.1) cm and 52.0 (4.0) to 53.4 (4.2). There were neither significant changes in body mass, running economy, degree of power development, nor in sprint time on 10 meters. The authors have concluded that the presentation of high-intensity running of football balls at intervals of 4 minutes over a specially designed path, along with the regular football training, is effective for improvement of maximal oxygen uptake for the players, without the interference of negative effects on strength, jumping ability and sprinting performance. The aim of this study was to determine differences in speed and functional abilities of football players of the first and the second football league.

Methods

The sample of respondents included in this study consisted of the players of the first and the second Serbian League, 22 players from FC “Rad” from Belgrade (First league) and 18 players from FC “Radnički” from Pirot (Second league). The football players of FC “Rad” were of average height 182.82 ± 7.05 cm and weight of 77.77 ± 6.59kg with a body mass index 23:25 ± 1.25.The football players of FC “Radnički“ were of average height of 180.28 ± 5.63 cm and weight 74.06 ± 6.97kg with a body mass index 22.76 ± 1.43.

The condition for participation in the study was that the players, on the day of the study, were clinically healthy and voluntarily agreed to be tested. The samples of variables for this study were speed and functional abilities of football players (by: Cazorla & Leger, 1993). Variables for speed evaluation: Maximum running speed between cones at 20 meters-MRS20, Maximum running speed on the track-MRST and Working speed-WORS. Variables for assessment of functional abilities: Maximal oxygen consumption-VO2M, Heart rate at rest-HRAR and Heart rate at the end of the test-HRET. In order to get the adequate answers in accordance with the aim of this study, the following statistical methods were made: Descriptive statistics - mean (MEAN), standard deviation (SD), minimum (MIN) and maximum (MAX) numerical result, the range (RANGE) and standard error of mean (ERROR). This statistics was applied to all manifested variables of speed and functional abilities. Discrimination measurements in this study were done by using Skewness (SKEW) which refers to the symmetry of particle distribution around the mean and Kurtosis (KURT) which refers to the elongation or fatnesses distribution. Multivariable MANOVA and univariable ANOVA analysis were used in order to show the differences between these two groups. The data were processed by software package Statistica 8.

Results and discussion

Table 1. Basic statistical parameters – FC "Rad"

Vars.	MRS20	MRST	WORS	VO2M	HRAR	HRET
N	22	22	22	22	22	22
Mean	13.98	17.10	17.20	56.42	61.45	194.18
Min	12.60	14.80	15.00	48.30	54.00	171.00
Max	15.00	18.50	18.50	62.60	66.00	206.00
Range	2.40	3.70	3.50	14.30	12.00	35.00
SD	0.54	0.91	0.88	3.24	3.69	8.99
Error	0.12	0.20	0.19	0.69	0.79	1.92
Skew	-0.35	-0.35	-0.29	-0.31	-0.68	-1.00
Kurt	0.75	0.44	0.25	0.70	-0.61	0.99

If we analyze table 1, which shows the basic statistical parameters of speed and functional abilities of players of FC "Rad" – Belgrade, we can conclude that all the tests have positive discrimination because their standard deviation is over 5 times smaller than their mean values. According to skewness, normal distribution symmetry around the mean in all tests can be observed. Kurtosis, however, indicates that the results of all variables are incompact (platykurtic data distribution). This is not surprising, because the tested footballers play at different positions. Table 2 presents the main statistical parameters of speed and functional abilities of football players of FC "Radnički" from Pirot. Analyzing, it can be noted that all the tests have positive discrimination because their standard deviation is over 5 times smaller than their mean values. According to skewness, there is normal distribution symmetry around the mean in most tests, except for the heart rate at rest testing (REHR), where the distribution curve is slightly left-oriented – there are some more results with smaller values of the mean.

Table 2. Basic statistical parameters – FC "Radnički"

Vars.	MRS20	MRST	WORS	VO2M	HRAR	HRET
N	18	18	18	18	18	18
Mean	13.61	16.53	16.64	54.27	60.39	197.06
Min	12.60	14.80	15.00	48.30	46.00	190.00
Max	14.90	18.50	18.50	61.90	66.00	205.00
Range	2.30	3.70	3.50	13.60	20.00	15.00
SD	0.52	0.85	0.82	3.08	5.37	4.57
Error	0.12	0.20	0.19	0.73	1.27	1.08
Skew	0.60	0.31	0.22	0.58	-1.30	0.12
Kurt	1.21	1.18	1.25	1.21	1.43	-0.68

Kurtosis, however, indicates that the results of all variables are incompact (platykurtic data distribution). This is not surprising because the tested players have different playing positions.

Table 3.Multivariable differences in speed

Test	Value	F	Effect - df	Error - df	p
Wilks	0.860	1.95	3	36	0.139

Table 3 presents the multivariable differences in speed between the football players from FC "Rad" from Belgrade and the football players from FC "Radnički" from Pirot. The analysis shows that there are no significant differences in speed between these two representatives of the first and the second league, statistically speaking.

Table 4. Univariable differences in speed

Variables	Rad/Radnički	N	Mean	SD	F	p
MRS20	Rad	22	13.98	0.54	4.90	0.03
	Radnički	18	13.61	0.52		
MRST	Rad	22	17.10	0.91	4.09	0.05
	Radnički	18	16.53	0.85		
WORS	Rad	22	17.20	0.88	4.34	0.04
	Radnički	18	16.64	0.82		

However, the analysis of table 4, which presents the univariable differences in speed between players of the first and the second league, it is obvious that significant differences exist in the test of maximum running speed between cones (MRS20) at $p = 0.032879$, and the test of operating speed (WORS) at 0.043995. Even the test of maximal running speed on the runway (MSTR) was on the verge of significance ($p = 0.05307$). These results are in accordance with research of Eklbom 1986 who claims that the higher levels of competition expresses a higher percentage of games at top speed, and this is confirmed by research of Mohr et al. 2003, who came to the realization that there are differences in running speed between the football players of the first and the second league. Also, these results may be related to the research of Aziz et al. 2008, which established the link between running repeated sprint ability test with a higher level of competitiveness and/or adaptation to resistance training. Table 5 presents the multivariable differences in functional abilities between these two clubs.

Table 5. Multivariable differences in functional abilities

Test	Value	F	Effect - df	Error - df	p
Wilks	0.822	2.59	3	36	0.067

It shows that there are no significant differences in functional abilities between these two representatives of the first and the second league, statistically speaking.

Table 6. Univariable differences in functional abilities

Variables	Rad/Radnički	N	Mean	SD	F	p
VO2MAX	Rad	22	56.42	3.24	4.57	0.04
	Radnički	18	54.27	3.08		
REHR	Rad	22	61.45	3.69	0.55	0.46
	Radnički	18	60.39	5.37		
HRET	Rad	22	194.18	8.99	1.52	0.23
	Radnički	18	197.06	4.57		

However, the analysis of table 6, which represents the univariable differences in functional abilities among the players of the first and the second league, it is obvious that significant differences exist only at the test of maximal oxygen consumption (VO2M) and at p = 0.039063. The other tests showed no statistically significant differences (REHR and HRET). This is in accordance with research of Helguerud et al. 2001, claiming that with increasing of maximum oxygen consumption in football players are increasing football performances too, and with the research of Ostojić 2002, who determined that players of other leagues have lower oxygen consumption compared to football players of the first league in Serbia.

Also, in the study of Mohr et al. 2003 and Vujović & Veljović 2010, it was shown that players who play in top teams have a higer oxygen consumption and therefore exceed the greater distances in high-intensity compared to the players in weaker teams.

Conclusion

On the basis of the fore mentioned research results, and in accordance with the aim, the following conclusion can be made: There are no significant differences in speed between the first and the second league players at the multivariable level, as well as in the maximum running speed on the track, statistically speaking. However, there are significant differences in the maximum running speed between the cones at 20 meters, as well as in the operating speed.

There are also no statistically significant differences in functional abilities at the multivariable level between the players of the first and the second division, as well as in the heart rate at rest and the heart rate at the end of the test. Statistically, the significant differences exist only in the maximum oxygen consumption between the first and the second football league. It means that the tests of the maximum running speed between cones at 20 meters, the operating speed and the maximal oxygen consumption may serve as a smaller battery of tests during the selection of players because they are a good predictor of the first league players success and that the fore mentioned qualities are prerequisite and a priority for participation in football at the elite level.

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RAZLIKE U BRZINI I FUNKCIONALNIM SPOSOBNOSTIMA NOGOMETAŠA PRVE I DRUGE LIGE

Sažetak

Cilj ovog istraživanja je bio utvrđivanje razlika u brzini i funkcionalnim sposobnostima nogometaša prve i druge lige. Uzorak ispitanika uključenih u ovo istraživanje sastojao se od 22 prvoligačka igrača i 18 drugoligaških. Uzorak varijabli sastojao se od po tri varijable za ocjenu brzine i funkcionalnih sposobnosti: maksimalna brzina trčanja između čunjeva na 20 metara, maksimalna brzina trčanja na stazi, operativna brzina, maksimalni primitak kisika, broj otkucaja srca u mirovanju i na kraju testa. Autori su zaključili da ne postoje statistički značajne razlike u brzini među nogometašima prve i druge lige na multivarijantnoj razini, kao ni u brzini trčanja na stazi. Međutim, postoje statistički značajne razlike u maksimalnoj brzini između čunjeva kao i u operativnoj brzini. Statistički, također nema značajnih razlika između igrača prve i druge lige na multivarijatnoj razini u funkcionalnim sposobnostima, kao ni univarijantno kod broja srčanih otkucaja. Statistički, značajne razlike postoje samo kod maksimalnog primitka kisika između igrača prve i druge nogometne lige.

***Ključne riječi**: nogometaši, prva i druga liga, brzina, funkcionalne sposobnosti, razlike*

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THE LEVEL OF THEORETICAL KNOWLEDGE ABOUT PHYSICAL EDUCATION AND PHYSICAL EXERCISE OF SECONDARY SCHOOL FEMALE STUDENTS

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Original scientific paper

Abstract

The research was performed with a goal of determining eventual differences between the effects of continuous planning and realization of programme contents of physical education and the effects of standard planning and realization of physical education programme contents, which is performed in cycles with a determined number of lessons on the level on theoretical knowledge about physical education and physical exercise of secondary school female examinees. The sample included 92 examinees divided into two characteristic sub samples: experimental group with 50 examinees which worked with continuous realization of planned contents of physical education and control group with 42 examinees which worked in cycles. In addition to number and percentage figures the following procedures were applied: multivariant analysis of variance, discriminative analysis and Roy's test. Parameters of multivariant analysis of variance and discriminative analysis denote statistically significant difference between experimental and control group of examinees only on final measurement in relation to the level of theoretical knowledge about physical education and physical exercise with the level of statistical significance p=.000. On final measurement between experimental and control group there is statistically significant difference in theoretical knowledge about physical education, in knowledge about team sports and in knowledge of individual exercise (sports).

Key words: *theory knowledge, physical education, physical exercise, female, secondary school*

Introduction

Fast changes in all aspects of human life demand constant reorganization of knowledge. According to Nenadić (2006) all life will represent time for studying. Education is considered to be individualized process which can be seen as an inner journey, an imaginary itinerarium whose stages correspond with constant process of personality development. There are not many works with the topics concerning theoretical knowledge of physical education and physical exercise. Višnjić (1979) indicates that the basis of physical education is specific education of students by physical exercise. Methods applied during physical education lessons have an influence on the level of student's transformation. Physical education can be considered as a subject of transformations. Acković (1975) in his work denotes that in physical education lessons lack the moment of creating educational process. The final goal of physical education is to enable student to use individually the possibility of physical culture in everyday life. In order to succeed in this a student has to acquire following knowledge: knowledge about the subject, knowledge about the influence of the subject on a person, knowledge about the exploitation of a subject in a sense of constant development and perfection of activities connected with the subject. The author recommends different forms which could help in distributing knowledge to students. Some of them are: lessons of body exercise with theoretical character; lessons of practical training during which students will get theoretical knowledge; physical education homework; and lectures.

He thinks that students do not need definitions on this subject, but active knowledge which will help them to understand the essentials of physical exercise. Students do not get necessary theoretical knowledge (Stanojević, 1986). This knowledge is insufficient as an influence on forming more positive attitudes towards physical education, which results in the fact that students are just objects and not the subjects of education. Parivash (2006) says those perceptive motor abilities, affective and cognitive development evaluate together and he indicates that there is positive connection of motor activity and the development of cognitive abilities.

That is the reason why schools should enrich their programmes and pay more attention to the development of perceptive – motor abilities of students. In this work by initial evaluation the level of theoretical work was determined done in primary schools and effects of experimental and control treatment tried to elevate the level of theoretical knowledge about physical education and physical exercise. This research will help us to see the reality and possible actions with the goal of improving the level of theoretical knowledge in physical education and physical exercise.

The subject and goal of the research

The subject of the research is the element of physical education of female examinees monitored through physical education lessons,i.e. the subject of this research is theoretical knowledge of physical education and physical exercise.

The goal of the research was to determine eventual differences between the effects of continuous planning and realization of programme contents of physical education lessons and the effects of standard planning and realization of programme contents of physical education, which is most often realized in cycles with a certain number of lessons for the level of theoretical knowledge about physical education and physical exercise of female students in secondary schools.

Methods

This research has longitudinal experimental character (pedagogical experiment with parallel groups) realized in two secondary schools and it lasted one school year. Physical education was planned and realized in 60 lessons. Experimental treatment was realized with 50 female examinees who were students of year one in Agricultural-veterinary school "Svilajnac" in Svilajnac, Republic of Serbia. Control treatment was realized with 42 female examinees who were the students of year one of "Secondary school of economy" in Svilajnac. Control group had lessons according to the standard plan of physical education (official educational programme for physical education, in cycles). Experimental group had lessons with the same programme content but differently planned. Experimental group had all 60 lessons using the system: one lessons of chosen sport with a ball (handball), one lesson of athletics, one lesson of handball, then athletics and so on until the cycle of 15 lessons of athletics was finished. Then handball was realized with the lessons of gymnastics with the same principle: one lessons of handball, one lessons of gymnastics and so on in continuity until this phase of 15 lessons was finished. During the whole school year there was a constant positive influence of sport game (handball), which did not stop with finishing of a cycle. *Variable* which was used in this research is student's knowledge. It has pedagogical character and by its nature it is qualitative. The applied instrument is test which consisted of twenty questions which aimed at covering children's general knowledge about physical education and physical exercise. Tasks were defined in a form of questions with alternative answers of different difficulty. Maximal score of test points was 100. For each female examinee a number of points was determined for each question as well as whole test score. With the aim of determining validity there was a probe research with the sample of 178 students of year one and two of secondary school. For evaluation of factor validity of applied instrument (test of knowledge) on complete sample, factor analysis was applied by the method of main components also with Warimah solution of rotation of main components. By the use of factor analysis nine main components were extracted whose characteristic roots (Egenvalue) were higher than one (1). The same metric structure was kept after the rotation of main components, which indicates that final piercomania was achieved, i.e. that the test has stable factor structure.

Extracted factors are relatively evenly saturated. So many factor got from twenty variables indicates relative independence of questions, i.e. on good validity. This conclusion is based on two more facts: firstly few questions indicated simultaneous projections on more factors and secondly communalities worked out for all questions were bigger than 0.5 which indicates that each of them carries sufficient quantity of information in order to be in the test. The biggest communalities were determined for the questions eight and nine. Because of such big number of factors and because of their difference, it was hard to divide each of them some logical complex name. All of this indicates that applied test has sufficient quantity of factor validity. It can be applied as an instrument for determination of student's general knowledge about physical education and physical exercise. Multivariant analysis of variance, discriminative analysis and Roy's test were applied in the processing of the data which were acquired by empirical research, apart from number and percentage indicators, in order to test the significance of differences between experimental and control group of female examinees in relation to theoretical knowledge.

Results

By the use of the analysis the differences between experimental and control group of female examinees were researched during initial and final evaluation in relation to three spaces of theoretical knowledge about physical education and physical exercise.

Table 1. Significance of differences between experimental and control group of female examinees during initial and final evaluation of the level of theoretical knowledge about physical education and physical exercise

Analysis	n	F	p
Manova – i	3	2.680	.052
Discriminative – i	3	2.680	.052
Manova – f	3	17.282	.000
Discriminative – f	3	17.282	.000

On the basis of the parameters of multivariant analysis of variance it can be stated that there is statistically significant difference between experimental and control group of female examinees only on final evaluation in relation to the level of theoretical knowledge about physical education and physical exercise. The acquired level of statistical significance on initial evaluation is p= .052, and on final evaluation p=.000.

On the basis of discriminative analysis, there is statistically significant difference and clearly defined limit between experimental and control group of female examinees, also only on final evaluation in relation to the level of theoretical knowledge about physical education and physical exercise. Statistically significant differences are in favor of experimental group of female examinees (Table 1).

Table 2. Significance of differences between experimental group and control group of female examinees on initial and final evaluation in relation to some spaces of the level of theoretical knowledge

Variables	Physical education lessons	Collective (exercise) sports	Individual (exercise) sports
χ	0.09	0.17	0.23
R	0.09	0.18	0.24
F	0.64	2.80	5.23
p	0.43	0.10	0.03
χ	0.32	0.44	0.37
R	0.33	0.49	0.39
F	10.94	28.39	16.11
p	0.00	0.00	0.00

On the basis of the values of Roy's parameters there is only statistically significant difference between experimental and control group of female examinees on intial evaluation about the knowledge about individual exercises – sports with the level of statistical significance p=.025. On final evaluation between experimental and control group of female examinees statistically significant difference is about the knowledge of physical education with the level of statistical significance p=.001, in knowledge about collective sports – with the level of statistical significance of p= .000 and in knowledge about individual exercise –sports with the level of statistical significance p=.000.

On initial evaluation there was statistically significant difference between the groups only in knowledge about individual exercises – sports. Statistically significant differences between the groups about the knowledge of physical education and collective exercises – sports on final evaluation, indicate the effects of experimental treatment which influenced improvements in knowledge in both spaces (Table 2).

Table 3. Discriminative coefficients between experimental and control group of female examinees on initial and final evaluation in relation to the state of the level of theoretical knowledge

Variables	Discriminative coefficients
Individual (exercise) sports - i	.054
Collective (exercise) sports - i	.029
Collective (exercise) sports – f	.200
Physical education lesson – f	.165

On the basis of discriminative coefficient in Table 3. on initial evaluation it can be seen that there is the biggest difference in knowledge about individual exercise – sports with the discriminative coefficient of .054. The reasons for differences, in the level of theoretical knowledge of female examinees are influence by ignorance of individual exercises – sports which is less present in realized contents of physical education lessons. There is the biggest difference between the groups on final evaluation about the knowledge of collective exercises – sports with the discriminative coefficient .200.

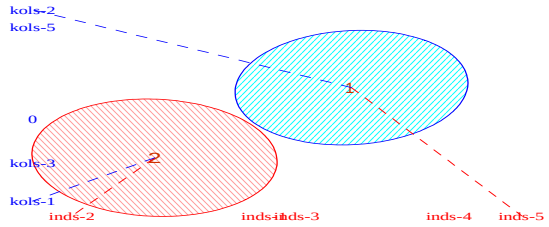
Table 4. Homogeneity of experimental and control group of female examinees on initial and final evaluation in relation to the state of theoretical knowledge about physical education and physical exercise

Groups	m/n	%
Experimental – i	28/50	56.00
Control – i	29.42	69.05
Experimental – f	39/50	78.00
Control – f	36.42	85.71

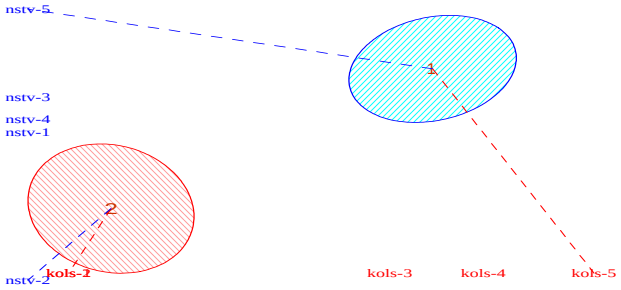
Homogeneity of female examinees on initial evaluation in experimental group is less and it is 56.00%. In control group with 42 female examinees thirteen have other characteristics and not the characteristics of their group, and homogeneity is 69.05%. Homogeneity of female examinees on final evaluation in experimental group, is also less and it is 78.00%. In control group out of 42 female examinees six of them have other characteristics and not the characteristics of their group and homogeneity is 85.71%.

Homogeneity in control group on final evaluation rose for 16.76%m and in experimental group for 19.71% on the basis of which it can be stated that there is higher increase of homogeneity in experimental group of female examinees (Table 4). On Graph 1. apcises represents knowledge about individual exercises – sports, with a five level scale of grades, and ordinate represent knowledge about collective exercises – sports with a four level scale of grades. In relation to axis knowledge about individual exercises – sports in control group of female examinees which is most represented is – sufficient knowledge, and in experimental group it is – excellent knowledge.

In relation to the axis of knowledge about individual exercises – sports for a control group of female examinees the most represented knowledge is – insufficient knowledge, and for experimental group it is excellent knowledge. On final evaluation on Graph 2. two most discriminative states were represented. On apcis there is knowledge about collective exercises – sports with a five level scale of grades, and on ordinate there is knowledge about physical education with a five level scale of grades. In relation to the axis of knowledge about collective exercises – sports in control group the most represented is – insufficient knowledge, and in sports in experimental group the most represented is sufficient knowledge. In relation to the axis of knowledge about physical education for control group of examinees the most represented is – sufficient and for experimental group – excellent knowledge.



Graph 1. Ellipses (interval of trust) of experimental and control group of female examinees on initial evaluation in relation to two most discriminative states of theoretical knowledge about physical education and ph. exercises



Graph 2. Ellipsis (interval of trust) of experimental and control group of female examinees on final evaluation in relation to two most discriminative states of theoretical knowledge about physical education and ph. exercises

Legend for both graphs: experimental (1) and control (2); insufficient (inds – 1); sufficient (inds – 2); good (inds – 3); very good (inds – 4); and excellent (inds – 5); insufficient (kols – 1); sufficient (kols – 2); good (kols – 3); very good (kols – 4); and excellent (kols – 5); insufficient (nstv – 1); sufficient (nstv – 2); good (nstv – 3); very good (nstv – 4) and excellent (nstv -5)

Discussion and conclusion

The level of theoretical knowledge about physical education and physical exercise on final evaluation indicates that knowledge about physical education in experimental group of female examinees is most often – excellent knowledge, and on initial evaluation it is –in sufficient knowledge. In the control group of female examinees on final evaluation the most often knowledge is – sufficient knowledge, and on initial evaluation it is – insufficient knowledge. For knowledge about collective exercises – sports in experimental group of female examinees on final evaluation the most often knowledge is –good and very good knowledge and on initial evaluation it is sufficient knowledge.

In control group on final and initial evaluation most often knowledge is – insufficient knowledge. For knowledge about individual exercises – sports in experimental group of female examinees on final and initial evaluation the most often knowledge is – good knowledge. In control group on final and initial evaluation the most often knowledge is – sufficient knowledge. In experimental group of female examinees there is the improvement of knowledge about physical education lessons and knowledge about collective exercises – sports. In control group of female examinees there is only improvement in knowledge about physical education lessons. Experimental treatment has influenced positive changes on the level of theoretical knowledge about physical exercises and physical education in experimental group of female examinees in relation to control treatment of female examinees. By the use of multivariant analysis of variance and discriminative analysis with the level of statistical significance p=.000, there is statistically significant difference between experimental and control group of female examinees on final evaluation, in relation to the level of theoretical knowledge about physical education and physical exercises. By the use of Roy's test there are statistically significant differences between experimental and control group of female examinees on final evaluation for all three categories of knowledge. Statistically significant difference in knowledge about physical education lessons did not exist on initial evaluation. Determined statistically significant difference on final evaluation states more positive influence of experimental treatment which had biggest influence on knowledge about physical education lessons.

The least difference on final evaluation of the level of theoretical knowledge about physical education and physcail exercise between experimental and control group is in knowledge about individual exercises (sports) with the discriminative coefficient .163. General conclusion on the basis of the results and differences between female examinees for experimental and control group could be defined in the following way. Physical education lessons with continuous education and improvement of programme contents, caused statistically significant influence on the level of theoretical knowledge about physical education and physical exercises of female examinees in experimental group and as such it can be reliable basis and recommendation to physical education teacher for modern physical education with permanent upgrading of present knowledge.

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RAZINA TEORIJSKOG ZNANJA O TJELESNOM ODGOJU I TJELESNOM VJEŽBANJU UČENICA SREDNJOŠKOLSKOG UZRASTA

Sažetak

Istraživanje je sprovedeno sa ciljem da se utvrde eventualne razlike između efekata kontinuiranog planiranja i realizacije programskih sadržaja nastave tjelesnog odgoja i efekata standardnog planiranja i realizacije programskih sadržaja nastave tjelesnog odgoja, koji se najčešće sprovodi u ciklusima s određenim brojem sati na razinu teorijskog znanja o tjelesnom odgoju i tjelesnom vježbanju ispitanica srednjoškolskog uzrasta. Uzorak je obuhvatio 92 ispitanice, podijeljene na dva karakteristična subuzorka i to: eksperimentalna grupa od 50 ispitanica, koja je radila sa kontinuiranom realizacijom planiranih sadržaja nastave tjelesnog odgoja i kontrolna grupa od 42 ispitanice, koja je radila po ciklusima. U obradi podataka pored brojčanih i procentualnih pokazatelja primjenjena je: multivarijantna analiza varijance, Roj-ev test i diskriminativna analiza. Parametri multivarijantne i diskriminativne analize ukazuju na statistički značajnu razliku između eksperimentalne i kontrolne grupe ispitanica samo na finalnoj procjeni u odnosu na razinu teorijskog znanja o tjelesnom odgoju i tjelesnom vježbanju. Ostvareni nivo statističke značajnosti na finalnoj procjeni je p=.000. Na finalnoj procjeni između eksperimentalne i kontrolne grupe ispitanica statistički značajna razlika postoji u znanju o nastavi tjelesnog odgoja, u znanju o kolektivnim vježbanjima (sportovima) i u znanju o individualnim vježbanjima (sportovima).

Ključne riječi: *teorijska znanja, tjelesni odgoj, tjelesno vježbanje, učenice, srednja škola*

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THE PRESENCE OF POORE POSTURE KIFOTIC IN ELEMENTARY SCHOOL, DEPENDING ON THE REASON FOR SPORT AVOIDING

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Original scientific paper

Abstract

The subject of this paper is to determine the presence of kifotic bad posture of primary school students, depending on the reason sports are not addressing. The research was conducted at the age of 12 years, + - 6 months, the sample was counted 299 students. To assess kifotic keeping low body it was used a method of somatoscopy and somatometry, in determining bad posture was used to mean mild criteria. Participation in sports activities, assessed by questionnaire fill up by the respondents. The reason for not practicing sports in the largest number of students are other reasons and the large membership, followed by distance from the residence of maintaining the desired discipline with sports, while the percentages of other reasons, very balanced. Kifotic bad posture, seen within the choice, most pronounced in the group answers to the candidate lives far away, followed by a group of patients whom the amount of the monthly fee is high, and those subjects with low achievement in school.

Key words*: kifotic posture, sport activities, pupils*

Introduction

A rapid and asymmetrical growth in children with other elements of the particular school age (carrying school bags, school conditions, the conditions for home, bed and pillow for sleeping, sitting chairs and so on) are certainly an important element in the emerging strain of the spinal column. Also, ″the reduction of physical activity, caused by the urban way of life, and inadequate exercise in physical education classes, and non-including in certain sports activities, leads to a weakening of the entire muscular system, and therefore to a weakening of the muscle area of the spinal column, which leads to specific disorders in the region in terms of poor posture, certain postural disorders, and finally the appearance of physical deformity (Bogdanović, 2008).

Disorders of posture in children, based on current research and statistics, mainly caused by muscle weakness of the region back, chest or abdomen. In addition, weakness of muscles pelvic belt and lower extremities can lead to secondary disturbances in the upper parts. The primary changes are usually first appear in the muscle, then there is a change in the ligament device, and at the end of the bone system. There are numerous researches on this point: Živković et al., 2006; Krsmanović & Bigović 2006; ; Protić-Gava et al., 2006; Krsmanović, 2007; Medojević et al., 2007; Milošević et al., 2008. Compared with urban children, the daily responsibilities of rural school children require physical activity throughout the day, so that their physical status as a rule, with minor deviations from normal. Research that was done to compare urban and rural school children, unambiguously confirmed that the ″village children with significantly smaller percentage of postural disorders in general″ (Živković et al., 1996).

Today, school children have been enabled, diverse and undoubtedly the quality of life content. There are many sports clubs, as collective and individual sports. Whereas in the urban environment are natural resources, developed and water sports, as well as some extreme sports. Research in this area indicate that a ″large percentage of students elementary-school age children do not take participation in sports activities″ (Bogdanović, 2006), and it was a determining reason why not deal with some of the sports that are present in the area.

Problem and aim

The subject of research is to determine the presence of disorder postural sagittal plane (kifotic bad posture) for primary school students, depending on the reason in sports, ie. of the reasons for not taking part in organized sports activities outside the regular hours of physical education. The aim was to determine the number of students with kifotic bad posture, and determine the presence kifotic poor posture, depending on the membership of a particular category of respondents listed as the reason for not practicing sports.

Methods

The survey was conducted in the city of Kragujevac in several elementary schools fifth-grade children (12 years + - 6 months), a sample was counted 299 students. To assess kifotic poor posture, was used and the method somatoscopy and somatometry. In determining bad posture, was used to mean more lenient criteria. All respondents who had more value than 35mm, were recorded as subjects with kifotic bad posture.

Not participating or not doing sports activities, the survey questionnaire assessed filled by respondents. To the question: What is the reason for not dealing with sports? Offered the following reply: I am not interested in sport, great fees, poor performance in school, live far, I have health problems and other reasons. Statistical significance between categories of respondents according to the indicators of control variables X, we calculate the square - test. The existence and size of the correlation between the investigated area was calculated Pearson correlation coefficient, which is in practice when working with linear models commonly used, and the coefficient of contingency as a measure of association based on the X square test. All analysis was performed on a personal computer using statistical package for data analysis (SPSS 8.1 Statistical Package of Social Sciences-For Windows).

Results

Table 1. Reason for not engage in sport

Reason	f	%
Not interested	15	5
Price	101	33,8
School success	14	4,7
Live far	46	15,4
Medical problems	8	2,7
Other	115	38,5
Total	299	100

From table 1 we see that the reason for not practicing sports at the highest number of students referred to as the second reason (38.5%) and a large membership (33.8%), respectively. high amount of the fee, which the parents of the respondents are not able to set aside a month for the child. The following is the distance of residence from the place where the desired disciplines with 15.4%, while the percentages of other reasons, very consistent.

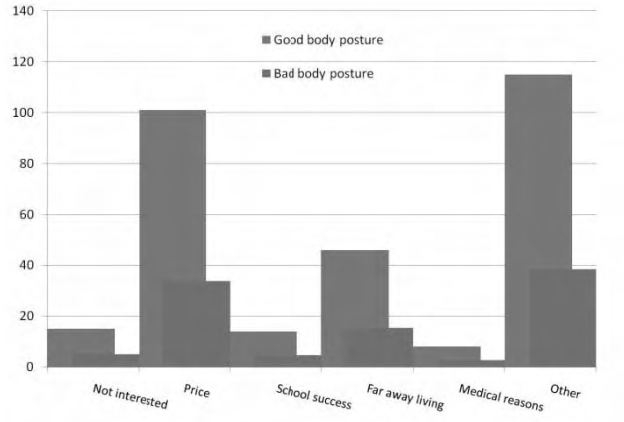

Chart 1. Reason for not engage in sport

This chart presents the reasons for not practicing sports and the presence of kifotic bad posture of the surveyed population, observed within the choice.

Table 2. Reason for not engage in sport * kifotic posture – Crosstabulation

		Good posture	Bad posture	Total
Not interested	Count	10	5	15
	%	66,67	**33,33**	100
Price	Count	53	48	101
	%	52,48	**47,52**	100
Success	Count	8	6	14
	%	57,14	**42,86**	100
Live far	Count	22	24	46
	%	47,83	**52,17**	100
Medical reasons	Count	5	3	8
	%	62,50	**37,50**	100
Other reasons	Count	72	43	115
	%	62,61	**37,39**	100
Total	Count	170	129	299
	%	56,86	**43,14**	100

Kifotic bad posture is most pronounced in the group answers to the respondent lives far away (52.17%), followed by a group of patients whose monthly fee high (47.52%), and those where the reason for not participating in sports activities, poor grades in school (42.86 %), while the percentage of responses in the other groups is very low and uniform.

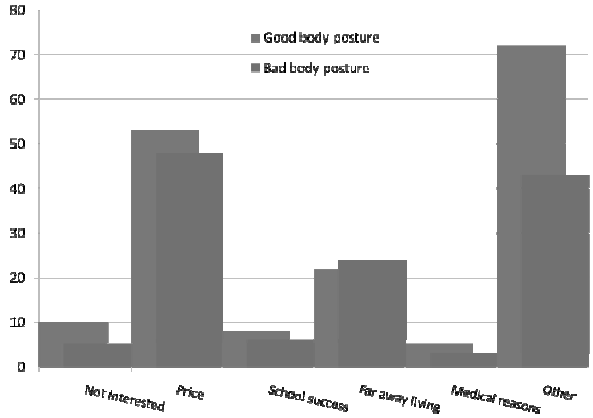

Chart 2. Reason for not engage in sport

Table 3. Reason for not engage in sport * kifotic posture – Crosstabulation

		Good	Bad	Total
Not interested	Count	10	5	15
	%	5,88	**3,88**	5,02
Price	Count	53	48	101
	%	31,18	**37,21**	33,78
Success	Count	8	6	14
	%	4,71	**4,65**	4,68
Live far	Count	22	24	46
	%	12,94	**18,60**	15,38
Medical reasons	Count	5	3	8
	%	2,94	**2,33**	2,68
Other reasons	Count	72	43	115
	%	42,35	**33,33**	38,46
Total	Count	170	129	299
	%	100	100	100

In table 3 the results, analyzed within categories kifotic poor posture. The highest percentage of poor posture is expressed in the group where the respondents answer a high monthly fee (37.21%), followed by other reasons with 33.33%, and the distance of residence from 18.60%, while the percentages in other groups of lower response and very consistent.

Table 4. Chi-Square Tests - Reason for not engage in sport * kifotic posture

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4,56	5	0,47
N of Valid Cases	299		

Table 5. Contingency Coefficient - Reason for not engage in sport * kifotic posture

Symmetric Measures	Value	Approx. Sig.
Nominal by Nominal	0,12	0,47
N of Valid Cases	299	

Discussion and conclusion

The reason for not practicing sports with the largest number of students are other reasons and a large membership, that is, amounts of fees by parents of the respondents are not able to set aside a month for the child. The following is the distance of residence from the place where desired sports, while the percentages of other reasons, very consistent.

Percentage of responses in the other groups lower and very uniform. The results, analyzed within categories kifotic poor posture, indicating that the largest percentage of poor posture expressed in the group where the respondents answer a high amount of monthly dues, followed by other reasons, and the distance of residence, while the percentage in other groups of lower response and very uniform.

Values of Pearson Chi-Square test and Contingency coefficient on the level of significance of 0:47, indicating the lack of statistically significant differences kifotic presence of poor posture, depending on the reason of participation in organized sports activities. From previous results, we concluded that a high percentage of children ages researchable, said that the reason for not practicing sports material nature.

Taking this into account, we say that it was necessary to take certain steps at all levels, in order to provide opportunities in the mass inclusion of preferred forms of sports and activities sport and recreational as broad strata of the population younger and older school-age children. Therefore to get to increase the quality of life, preventive effect on the appearance of a variety of postural disorders and physical deformities that are increasingly affecting the investigated area.

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PRISUSTVO KIFOTIČNOG LOŠEG DRŽANJA KOD OSNOVNOŠKOLSKOG UZRASTA U ZAVISNOSTI OD RAZLOGA NEBAVLJENJA SPORTOM

Sažetak

Predmet ovog rada je utvrđivanje prisustva kifotičnog lošeg držanja tijela kod učenika osnovnoškolskog uzrasta u zavisnosti od razloga nebavljenja sportom. Istraživanje je sprovedeno na uzrastu od 12 godina, + - 6 meseci, a uzorak je brojao 299 učenika. Za procjenu kifotičnog lošeg držanja tijela, korištena je metoda somatoskopije i somatometrije, a u utvrđivanju lošeg držanja korištena je srednja vrijednost blažeg kriterija. Nesudjelovanje u sportskim aktivnostima, procjenjivano je anketnim upitnikom popunjavanog od strane ispitanika. Razlog nebavljenja sportom kod najvećeg broja učenika su 'drugi' razlozi i visoka članarina. Slijedi udaljenost stanovanja od mjesta održavanja željenih sportskih disciplina, dok su procenti ostalih razloga veoma ujednačeni. Kifotično loše držanje tijela, promatrano unutar ponuđenih odgovora je najviše izraženo u grupi odgovora da ispitanik daleko stanuje, slijedi grupa ispitanika kojoj je iznos mjesečne članarine visok i ispitanici sa slabim uspjehom u školi.

***Ključne riječi**: kifotično držanje, nebavljenje sportom, učenici*

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DIFFERENCES BETWEEN BOYS AND GIRLS IN PHYSICAL ACTIVITY

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Original scientific paper

Abstract

Physical activity of the schoolchildren is important factor of their regular development. The aim of this investigation was to examine the occurrence of the differences between boys and girls in the level of the physical activity. 98 schoolchildren (48 boys and 50 girls) average age 11, 4±0, 58 years were tested by Physical activity score that included data about of the level of physical activity (9 variables) as well as back pain and estimates of general health. Binary logistic regression for analyze of the date was used. Dependent variable was sex. Results of our investigation show that significant predictor of differences between boys and girls in the level of physical activity was game (time spent outside) (OR=0,398, p<0, 05), when these variable were controlled by other independent variables. Our investigation showed that games are significant predictor of differences in physical activity between boys and girls.

***Key words**: children, physical activity, game*

Introduction

Physical activity is critical for children's normal growth and development. A lack of physical activity has independent associations with other health problems during childhood, including childhood obesity (Krebs & Jacobson, 2003; Lobstein, Baur, & Uauy, 2004; Butland, 2007), metabolic impairments (Imperatore, Cheng, Williams, Fulton & Gregg, 2006; Andersen et al., 2006; Garemo, Palsdottir & Strandvik, 2006; Ekelund et al., 2007; Williams & Strobino, 2008) and poor skeletal health (Prentice et al., 2006; Hind & Burrows, 2007). Research studies confirm the health benefits of regular physical activity. Increasing physical activity and improving dietary habits in childhood have therefore been identified as targets for future public health policy (Department of Health, 2004; Butland, 2007). This will help the identification of populations at risk and the development of interventions to promote change in these health behaviours. Previous studies have reported mixed results, with the proportion of children achieving the recommended guideline of at least one hour of moderate-to vigorous intensity physical activity (MVPA) each day (11) varying from 2,5 to 97% (Pate et al., 2002; Department of Health, 2004; Riddoch et al., 2004; Riddoch et al., 2007; Spinks, Macpherson, Bain & McClure, 2007). This large variation mainly depends on the population studied and the variation in data processing methods applied. However, most studies indicate that physical activity levels decline with age, especially during late primary school years (Sallis, Prochaska & Taylor, 2000; Kimm et al., 2002; Sherar, Esliger, Baxter-Jones & Tremblay, 2007), making this a potentially important period for health promotion interventions. Previous studies are focused on physical activity and dietary behaviour of 9-10-year old British children (Van Sluijs, Skidmore, Mwanza, Jones & Callaghan, 2008), ethnic and gender differences in physical activity levels among 9–10-year-old children (Van Sluijs, 2008), overweight children (Binns et al., 2009; Maddison, 2009), physical activity and good health (Blair, Kohl, Gordon & Paffenbarger, 1992), association of blood pressure with BMI, physical activity and cardio respiratory fitness in youth (Gaya et al., 2009). The SPEEDY study (Sport, Physical activity and Eating behaviour: Environmental Determinants in Young people) was established to examine physical activity levels and dietary behaviour in a large population-based sample of British 9–10 year old children, and to investigate the individual and collective factors associated with these behaviours. Although there is some information available on the physical activity of school aged children (Kimm et al., 2002; Van Sluijs, Skidmore, Mwanza, Jones & Callaghan, 2008), little is known about differences between boys and girls in physical activity. The aim of this investigation was to examine the occurrence of the differences between boys and girls in the level of the physical activity in the schoolchildren aged 11-12 years.

Methods

Ninety-eight schoolchildren (48 boys and 50 girls) were included in this study. Average age of children was 11, 4±0, 58 years (Table 1). All children were tested by Physical activity score that included data about of the level of going in for learning, sedentary screen-based activities (video gaming, computer science), classes of physical education, corrective exercises, game (time spent outside), sports activity, training, warming up before training and walking. Physical activity score included free time and organized physical activity, sedentary activities as well as variables that are potentially related to children's physical activity. (The presence and level of the back pain and estimates of general health were also included in the test). Physical activity score was based on self-reported data with estimate of intensity and lasting of any of certain 9

activities and 2 conditions. Minimum score was"0", Maximum score was "4" (score from 0 to 4, from best to worst). Responses were scored as following: the best (normal) scoring by "0", satisfactory "1", moderate "2", poor "3", the worst (extreme) by "4". Learning and sedentary screen-based activities (video gaming, computer science) were estimated by number 4 if those activities last 4 or longer hours. Student-t test was used for estimates statistical significance of difference of age between boys and girls. Binary logistic regression was used in order to investigate of predictors of differences between boys and girls in activities, back pain and general health.

Table1. Characteristics of study sample (n=98)

Parameter	Boys		Girls		Total	
	N^0	%	N^0	%	N^0	%
	48	49	50	51	98	100
Average age (years)	11,41		11,48		11,4	
SD	0, 67		0,57		0,58	

Dependent variable was sex and independent variables were going in for learning, sedentary screen-based activities (video gaming, computer science), classes of physical education, games (time spent outside), sports activity, training warming up before training, walking, back pain and estimates of general health. Statistical significance of differences was on the level of p<0, 05.

Results

Average age of the participants in our study was 11, 4±0, 6 years (11, 5±0, 6 for girls and 11, 4 ± 0, 7 for boys). This difference was not statistically significant (t= 0, 42, p>0, 05). Average values of independent variables of the participants (score from 0 to 4, from best to worst) were presented on the Table 2. We can see that children the time spent in learning scored by 3, 24. The children in our study spent a little time in sport activity and this activity was estimated by 3, 08 scores. Warming up before training is insufficient (2, 84). Back pain is unusual and estimates of general health are good (0, 49 and 0, 63 scores).

Table2. Average value of independent variables (score from 0 to 4, from best to worst), n=98

Variable	Min	Max	Mean	SD
Learning	0,0	4,0	3,24	0,99
Sedentary	0,0	4,0	1,33	1,66
Classes of physical education	0,0	4,0	1,35	1,68
Corrective exercises	0,0	4,0	2,37	1,88
Games (time spent outside)	0,0	4,0	2,12	1,58
Sports activity	0,0	4,0	3,08	1,55
Training	0,0	4,0	2,82	1,82
Warming up before training	0,0	4,0	2,84	1,69
Walking	0,0	4,0	1,24	1,51
Back pain	0,0	4,0	0,49	1,00
Estimates of general health	0,0	4,0	0,63	1,27

Note: Sedentary = screen-based activities (video gaming, computer science)

Boys had lesser scores than girls in all activities except learning. Estimates of general health were worse in girls than in boys (1, 04 and 0, 45), as well as back pain (2, 78 and 0, 14). Results of our investigation show that significant predictor of differences between boys and girls in the level of physical activity was game (OR=0,398, p<0, 05), when this variable was controlled by other independent variables (Table 3).

Table3. Confounders related to the sex (boys and girls) on multivariate logistic regression analysis (sex was the dependent variable), n=98

	Boys		Girls		Logistic regression analysis	
Variable	Mean	SD	Mean	SD	p - value	Odds ratio (95 CI)
Learning	4	1,02	3,96	1,02	>0,05	0,48
Sedentary	1,18	1,65	1,44	1,69	>0,05	1,04
Classes of physical ed.	1,14	1,64	1,51	1,72	>0,05	1,28
Corrective exercises	1,77	1,92	2,85	1,72	>0,05	0,48
Games (time spent outside)	1,64	1,46	2,52	1,58	**<0,05**	0,40
Sports activity	2,54	1,76	3,52	1,22	>0,05	33,66
Training	2,00	2,05	3,48	1,31	>0,05	0,03
Warming up before training	2,23	1,80	3,33	1,44	>0,05	0,81
Walking	1,04	1,49	1,41	1,52	>0,05	1,10
Back pain	0,14	0,47	2,78	1,62	>0,05	0,13
Estimates of general health	0,45	1,22	1,04	1,79	>0,05	0,69

Note: Sedentary = screen-based activities (video gaming, computer science)

There was the change in odds for a unit increase in the variable. Games (time spent outside) and increasing of the probability to be boy (the odds ratio tends to be less than 1). Game was significant predictor of sex differences in school children aged 11-12 years, but learning, sedentary screen-based activities (video gaming, computer science), classes of physical education, corrective exercises, sports activity, training, warming up before training, walking, back pain and estimates of general health were not.

Discussion

The aim of the current paper was to present data on physical activity of boys and girls and their behaviour from sample of one school from Banjaluka with11-12 years old children. Previous reviews of correlation in youth physical activity have given conflicting results. Differences in various investigations may occur because of different methods of measurement, different instruments and variables that were included.

These differences could be because of differences among countries and different socioeconomic and cultural conditions, also. Results of our study showed that game was significant predictor of sex differences in school children aged 11-12 years, but learning, sedentary screen-based activities (video gaming, computer science), classes of physical education, corrective exercises, games (time spent outside), sports activity, training, warming up before training and walking were not. Boys were more likely to be physically active than girls. Girls recorded significantly less activity in game (time spent outside) than boys did. This is in accordance with other reports (Sallis, Prochaska & Taylor, 2000; Spinks, Macpherson, Bain & McClure, 2007; Van Sluijs, Skidmore, Mwanza, Jones & Callaghan, 2008; Hinkley, Crawford, Salmon, Okely & Hesketh, 2008; Maddison, 2009). Girls recorded more time in sedentary activity and less time in light, moderate and vigorous activity. In all ethnic groups combined, girls recorded less activity than boys (Maddison, 2009) did. Hinkley et al. (2008) reported that preschool children who spent more time outdoors were more active than children who spent less time outdoors, also (Hinkley, Crawford, Salmon, Okely & Hesketh, 2008). Our results show that Physical activity score based on self-reported data can monitor differences in levels of activity. Self-report methods are still likely to be a principal source of information for many studies. However, there is a report (Sproston & Mindell, 2006) that gender differences in self-reported levels of activity (with 69% of boys and 61% of girls reporting recommended levels) were less marked than those measured objectively (76 vs. 53%, respectively).

Strengths and weaknesses

The study was designed to allow schoolchildren (boys and girls) comparisons limiting the influence of confounders. We have included all available data and have adjusted for all factors related to sex differences (boys and girls) in relation to physical activity. These may be strengths of this study. The primary limitation of the study was that we could not include as confounders emotional health domains, BMI, previous physical activity. Due to potential gender biases in reporting of physical activity, objective measures offer a more reliable form of assessment. Therefore, further investigations are needed.

Conclusion

Our investigation showed that game is significant predictor of differences in physical activity between boys and girls and that boys are more playing game than girls are. This study provides understanding of the factors that influence physical activity. It can aid design of more effective interventions for school aged girls and boys. These results may promote more active lifestyles among children, especially girls.

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RAZLIKE IZMEĐU DJEČAKA I DJEVOJČICA U TJELESNOJ AKTIVNOSTI

Sažetak

Tjelesna aktivnost djece školskog uzrasta je veoma važan faktor pravilnog razvoja. Cilj ovog istraživanja je bio da se ispita postojanje razlika između dječaka i djevojčica u nivou fizičke aktivnosti. Ukupno 98-oro djece školskog uzrasta (48 dječaka i 50 djevojčica) prosječne starosti 11, 4±0,58 godina je testirano Testom fizičke aktivnosti (Physical activity score) koji uključuje podatke o nivou fizičke aktivnosti (9 varijabli), kao i bol u leđima i ocjene općeg zdravlja. Za statističku analizu podataka korištena je Binarna logistička regresija. Zavisna varijabla je bila spol. Rezultati istraživanja pokazuju da je igra (vrijeme provedeno vani) značajan prediktor razlika između dječaka i djevojčica u nivou fizičke aktivnosti (OR=0,398, p<0, 05), kada su varijable kontrolirane sa drugim nezavisnim varijablama. Ovo istraživanje pokazuje da postoji razlika u fizičkoj aktivnosti između dječaka i djevojčica i da dječaci provode više vremena u igri vani od djevojčica.

***Ključne riječi**: djeca, fizička aktivnost, igra*

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CONTRIBUTION OF THE EXPERIMENTAL PROGRAM TO THE DEVELOPMENT OF FUNCTIONAL ABILITIES OF THE SCHOOLGIRLS

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Original scientific paper

Abstract

The purpose of this research is to determine how much is the specially programed performance of physical education, with increased demands and application of additional exercises, influenting the functional abbilities. Research had a longitudinal caracter, and experimental program was carried out on the sample of 97 first-grade schoolgirls of the elementary schools in Leposavić and Zvečan, age of 7 years ± 6 months. The sample is divided into two groups: experimental group 56 and control one 41 schoolgirls. Six metrical instruments were used for evaluation of functional abbilities of schoolgirls. Final data processing included only the examinees that participated at initial and final measurement. Basic statistic parametars were calculated by processing of data during initial and final measuring. In order to evaluate the influence of the experimental programme on functional abilities of the schoolgirls it is necessary to determine if there are possible differences between the abilities of the schoolgirls of the experimental and control groups in the initial measurement, therefore a multivariate analysis of variance (MANOVA) was applied, and univariate analysis of variance (ANOVA) was applied. Multivariant and univariant analisys of variance for repeated measures (MANOVA and ANOVA – repeated measures) were applied for determination of eventual differences between initial and final measuring. The multivariant analysis of covariance (MANCOVA) and univariant analysis of covariance (ANCOVA) were applied in order to determine the effects of the experimental program. Based on retrieved results it could be concluded that specially programed performance of physical education had a significant influence on changing the most functional abbilities of schoolgirls. The results of this paper can be used by PE teachers giving them the information on adequate planning and programming of the classes.

Key words: *schoolgirls, experimental programme, functional abbilities, MANOVA, ANOVA*

Introduction

Ever increasing development of the civilization has its advantages such as advancement of humankind but also it has some negative influences since the inactive life with limitied time spent outdoors and insufficient moving decreases a development of functional abilities and consequently causes the occurrence of deseases. Recently it has been widely claimed that children are less and less physically active which results in inadequate development of motor and functional abilities. This refers first of all to the younger pupils as one of the most important chains in the process of education.

If one aspires to act more significantly on the anthropological status of children it is necessary to apply high intensity exercising which is hard to find in the real pedagogical work. Inadequte volume of load will not contribute to the systematic changes of motor abilities and especially functional abilities which are the research topic of this paper. There is a need for more contemporary and more efficient physical education with contents that will enhance more opportunities for the holistic development of children. To successfully manage the process of physical exercising in the physical education teachers should excel in their expertise knowledge directed at the application of adequate teaching methods, exercising, dosing of exercises, choice of exercises and methods to assess the obtained results.

All this will inevitably put more demands on the teachers and pupils as well and will call for more qualitative realization of the abovementioned contents.

Research topic and aim

Having in mind that classical physical education curricula provide for insufficient opportunities for the development of pupils functional abilities our purpose was to determine the effects that specially designed and programmed physical education curricula with the emphasized contents in athletics, sports games, requisite games and floor exercises, rhythmics and dance and some additional exercises would produce. All the experimental programs' contents were divided thematically and were ciclically repeated so as to provide for better systematicity and the stability of the realized effects. The basic aim was to determine if the application of the proposed physical education curricula will provide for the positive changes of functional abilities of the experimental group of schoolgirls. Besides, the research aim was also to determine the effects of the existing physical education curricula and the changes its implementation brings about in the functional abilities of the control group of schoolgirls. The effects of the experimental programs were observed and monitored by comparing the results of the initial and the final measurements of the functional abilities of the schoolgirls.

Subject sample

Subject sample comprised the first grade elementary schoolgirls from Leposavic and Zvecan. The schoolgirls attend and undergo regular physical education curricula envisaged by the PE Curricula of the Republic of Serbia. Research sample comprised 97 subjects divided into two groups: experimental group 56 and control group of 41 schoolgirls.

Variables

Following parameters were used for the investigation of functional abilities: a) for the estimation of the cardiovascular system and overall functional abilities (vital capacity (FVKAP) cm^3; systole blood pressure at rest (FTASI) mmHg; dyastol blood pressure at rest (FTADI) mmHg; heart beat at rest (FPUMI) beat/min; heart beat after loading (FPPOP) beat/min; b) for the estimation of the adaptedness of the cardiovascular system to the physical strain (modified Harvard step-test (FHAST) in index points (Mazure vers.). Investigation of the functional abilities was conducted at the beginning and in the end of the school year in the physical education classroom.

Data processing

This was a longitudinal research. Experimental program was realized within one school year with three periods a week. The obtained data in the initial and final measurements were processed with the adeqate methods envisaged to provide complete information on the research problem. Basic statistical parameters for all variables were calculated. To determine the differences between the initial and the final measurements and to determine how much each group had advanced during the experimental treatments multivariate and univariate analyses for the repeated measures (MANOVA and ANOVA – repeated measures) were applied. In order to determine the effects of the proposed experimental program MANCOVA and ANCOVA were applied to neutralize the possible differences between the groups in the initial measures.

Results

Differences between the groups in the initial measurements

In order to evaluate the effecs of the experimental programme on functional abilities of the schoolgirls it is necessary to determine if there are possible differences between the abilities of the schoolgirls of the experimental and control groups in the initial measurement, therefore a multivariate analysis of variance (MANOVA) was applied, and to obtain the data in which variables possible differences occur a univariate analysis of variance (ANOVA) was applied.

On the basis of the results of the multivarite analysis of the variance for the functional abilites between the schoolgirls of the experimental and control groups in the initial measurements (table 1), it can be stated that there is not statistically significant intergroup difference (p = .641).

Table 1. Multivariate differences in functional abilities between the experimental and control groups of schoolgirls in the initial measurement

Wilk's Lambda	F	Effect df	Error df	p
0.955	0.71	6	90	0.641

Table 2. shows the results of the univariate analysis of the variance in the applied variables of the functional abilities of the schoolgirls in the initial measurement. It can be noticed in the test for the estimation of the cardiovascular system and overall functional abilities, vital capacity (FVKAP), better results on this test were achieved by the schoolgirls of the control group, whose mean value reads 1243.90 cm^3, and experimental group reads 1237.50 cm^3 .

Table 2. Univariate differences in functional abilities between the experimental and control groups of schoolgirls in the initial measurement

Test	Mean E	Mean K	F (1,95)	p
FVKAP	1237.50	1243.90	0.02	0.88
FTASI	95.09	94.76	0.05	0.82
FTADI	58.57	59.76	0.99	0.32
FPUMI	97.86	98.46	0.31	0.58
FPPOP	132.82	133.39	0.16	0.69
FHAST	41.17	40.86	0.43	0.51

In all variables there were not registered statistically significant differences, but it can be concluded that the schoolgirls in experimental and control group are no differ in their functional abilities in the initial measurement.

Differences between the initial and final measurements

As seen in Table 3., which shows the results of the multivariate analysis of variance in the experimental group of the schoolgirls it can be concluded that after the implementation of the experimental program statistically significant changes on a multivariate level occurred (p = .000).

Table 3. Multivariate differences between the initial and final mesurements (MANOVA-repeated measure) in functional abilities of the experimental group of schoolgirls

Wilk's Lambda	F	Effect df	Error df	p
0.022	366.19	6	50	0.000

As seen in Table 4., which shows the results of the univariate analysis of variance of the functional abilities in the experimental group of schoolgirls it can be concluded that after the experimental program implemented statistically significant changes in all variables occurred in a positive sense on a level of significance of p < .000, because all abilities were increased during the experimental phase. The most remarkable changes after the experiment were noticed in test for the estimation of the cardiovascular system and overall functional ability: heart beat after the load (FPPOP), whose value of F-test was 1094.80, vital capacity (FVKAP), (F = 836.58) and the test for the

estimation of the adaptedness of cardiovascular and respiratory system to physical strains, modified Harvard step-test (FHAST) (F = 960.11). In all other variables these values were somewhat smaller but statistically significant. As seen in Table 5., which shows the results of the multivariate analysis of variance of the functional abilities in the control group of schoolgirls, it can be concluded that after the experimental program implemented statistically significant changes on the multivariate level occurred (p = .000).

Table 4. Univariate differences between the initial and final measurements (ANOVA-repeated measure) in functional abilities of the experimental group of schoolgirls

Test	Mean initial	Mean final	F (1,55)	p
FVKAP	1237.50	1480.36	836.58	0.00
FTASI	95.09	99.11	225.00	0.00
FTADI	58.57	62.68	253.00	0.00
FPUMI	97.86	94.16	26.31	0.00
FPPOP	132.82	124.23	1094.80	0.00
FHAST	41.17	44.03	960.11	0.00

Table 5. Multivariate differences between the initial and final mesurements (MANOVA-repeated measure) in functional abilities of the control group of schoolgirls

Wilk's Lambda	F	Effect df	Error df	p
0.029	193.37	6	35	0.000

As seen in Table 6., which shows the results of the univariate analysis of variance of the functional abilities in the control group of schoolgirls, it can be concluded that after the experimental program implemented statistically significant changes occurred in all variables in a positive sense on the level of significance p < .05, due to the increase of all abilities during the experimental period.

Table 6. Univariate differences between the initial and final mesurements (ANOVA-repeated measure) in functional abilities of the control group of schoolgirls

Test	Mean initial	Mean final	F	p
FVKAP	1243.90	1395.12	154.69	0.00
FTASI	94.76	99.51	780.00	0.00
FTADI	59.76	64.02	167.81	0.00
FPUMI	98.46	96.27	8.28	0.01
FPPOP	133.39	130.66	25.28	0.00
FHAST	40.86	41.84	16.35	0.00

Biggest changes during the experimental period were registered in test for the estimation of the functioning of cardiovascular system and overall functional ability: systole blood pressure at rest (FTASI), whose value of F-test was 780.00, dyastol blood pressure at rest (FTADI), (F=167.81), vital capacity (FVKAP), (F = 154.69) and heart beat after loading (FPPOP), (F = 25.28). In the rest of the variables these values are somewhat smaller but they are statistically significant. Changes registered in the functional abilities of the control group are of smaller intensity when compared to the changes in the experimental group from the values of F-test. Values of F-test in the experimental group are remarkably bigger (most of them range from 1094.80 to 26.31), and in control group they range from 780.00 to 8.28).

Effects of the experimental program on the functional abilities

As seen in Table 7., which shows the results of the multivariate analysis of covariance in functional abilities between the experimental and control groups of the schoolgirls in the final measurement, it can be concluded that there is statistically significant intergroup difference on the level of (p = .000).

Table 7. Multivariate differences in functional abilities between the experimental and control groups of schoolgirls in the final measurement (MANCOVA)

Wilk's Lambda	F	Effect df	Error df	p
0.339	27.3	6	84	0.000

Table 8., shows the results of the univariate analysis of the covariance in the applied variables of the functional abilities between the experimental and control groups of the schoolgirls in the final measurement.

Table 8. Univariate differences in functional abilities between the experimental and control groups of schoolgirls in the final measurement (ANCOVA)

Test	Adj. Mean E(56)	Adj. Mean K (41)	F (1,89)	p
FVKAP	1480.62	1394.86	36.75	0.000
FTASI	99.01	99.61	3.23	0.076
FTADI	63.27	63.44	0.17	0.681
FPUMI	94.25	96.18	6.35	0.014
FPPOP	124.49	130.4	127.21	0.000
FHAST	43.94	41.93	12.06	0.000

Statistically significant differences on the univariate level were registered in favour of the experimental group of schoolboys in variables: vital capacity (FVKAP) and heart beat after loading (FPPOP) and the variable of the modified Harvard step-test (FHAST), heart beat at rest (FPUMI). Statistically significant differences were not registered in systole blood pressure at rest (FTASI) and dyastol blood pressure at rest (FTADI).

Discussion

Reality of the obtained data of the functional variables on the initial measurement is based on the previous research and the experience of the national researchers (Stojanović, 1977; Zrnzević, 1984; Krsmanović, 1985; Petrović, 1988; Sabo, 2002; Đurašković, 2002; Kragujević, 2004). Considering these data it can be said that the obtained values are real and expected ones. The initial measurement analyses show that the schoolgirls of experimental and control groups are no differ in their functional abilities. Values of the arithmetic means state that there was positive increase or decrease in all measured variables on the final in relation to the initial measurement and that the changes in the experimental group are more substantial than the changes in control group of schoolgirls. Results of MANOVA and ANOVA analyses of variance for the repeated measures (Tables 3, 4, 5 and 6), have shown that changes occurring during the experimental period are

statistically significant in both groups and are significantly bigger in the experimental group which is revealed in F-test values. On the final measurement values of vital capacity (FVKAP) were bigger by 243cm^3. Significant increase in the vital capacity is possible to explain by the increased physical activity, foremost by the application of the exercises for endurance (repetitive power exercises). They are meant to increase the frequency of breathing, to widen the muscles of the chest, to increase the elasticity of the interrib muscles, to widen the respiratory system so as to enhance the breathing. All these contribute to the better adaptedness of the respiratory system to the physical strains which results the increased vital capacity of the lungs. The more frequent and more intensive the activities the better results are achieved. Average values of the blood pressure systole (FTASI) and dyastol (FTADI) increased by about 4mmHg which is considered real increase and is thought of as normal for this age. Bearing in mind that schoolgirls of this age exhibit overwhelming reactions to some testings there is a possibility that values of systole and dyastol blood pressure at rest of some schoolgirls were increased. Level of blood pressure is affected also by the emotional states such as excitement and it can cause its increase. Final measurement showed decreased values of the heart beat at rest (FPUMI) and heart beat after load (FPPOP), which is considered positive. Regular physical activities enhance decreased values of heart beat at rest and values of heart beat after load. Heart beat rate at rest is difficult to determine precisely because physical exertion of the body and emotional unrests are hard to control. Lower pulse at rest gives rise to better adaptedness to increased bodily strains and efforts which was confirmed after the implementation of the experimental treatment resulting in dicreased pulse after the overload. Harvard step-test (FHAST) is meant to estimate the efficiency of the cardio-vascular system to adapt to the physical strains. Improvement of results for three index points in experimental group is extremely important in physical education curricula and especially while planning the loading at this age. Experimental program has shown that systematic exercising and optimal physical exercising bring about increase of the vital capacity and decrease of the pulse at rest even after load. Cardiovascular and respiratory systems are gradually adapted to the strains and efforts which contributes to the economy of their functioning. During experimental treatment it was insisted on more frequent performance of some activities whereby special role was assigned to ″supplementary exercises″, resulting in more effective development of the functional abilities of the experimental group of schoolgirls. Effects of the experimental program were determined by means of MANCOVA and ANCOVA analyses. Statistically significant differences in the final measurement between the experimental and control groups of schoolgirls were not registered neither in systole blood pressure at rest (FTASI) and dyastol blood pressure at rest (FTADI). Since the changes in the level of the functional abilities of the experimental group of schoolgirls are more prominent it is clear that the experimental program of physical education was so envisaged to enhance the development of all functional abilities evenly. Changes occurred as a consequence of the experimental program implementation but also to a lesser extent, as a result of the growth and development. Growth and development contribute to the improvement of some of the functional abilities such as the vital capacity increase and puls at rest decrease, but substantial increase is possible to reach by the application of increased physical activities over a long period of time. When checking the effects of the implementation of both programs between the initial and the final measurements it was determined that both programs influenced the occurrance of statistically significant changes in the functional abilities of the schoolgirls, but these results are much bigger within the experimental group.

Conclusion

After the implementation of the experimental program it was determined that on a multivariate level there is statistically significant difference in the experimental group of schoolgirls between the initial and the final measurements. Statistically significant difference between the initial and the final measurements was also found in the control group. On an univariate level it was determined the existance of statistically significant differences in all variables in a positive sense both in the experimental and the control groups. When determining the effects of the experimental program analyses had shown that on a multivariate level there is statistically significant difference between the experimental and the control group on a final measurement. On an univariate level it was determined the existance of statistically significant differences in all variables in favour of the experimental group of schoolgirls except for the variables: systole blood pressure at rest (FTASI) and dyastol blood pressure at rest (FTADI).

After the performed analyses and on the basis of the obtained results it can be concluded that the experimental program of physical education with the emphasis on the athletics, sports games, requisite games and floor exercises, rhythmics and dance and some additional exercises during the main part of the class did statistically significantly influence and cause changes in the functional functional abilities of the experimental group schoolgirls. In order to achieve positive results it was necessary to increase the demands and to increase the motivation for the work. Additional exercises had contributed to the density of the class, had increased the intensity of the exercises and had enhanced more substantial engagement and independence on the side of the schoolgirls and more rational use of the requisites and apparatus in PE classes.

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DOPRINOS EKSPERIMENTALNOG PROGRAMA RAZVOJU FUNKCIONALNIH SPOSOBNOSTI UČENICA

Sažetak

Ovaj rad je imao za cilj da utvrdi u kojoj meri posebno programirana nastava tjelesnog odgoja, s povećanim zahtjevima i primjenom dopunskih vježbi, utječe na poboljšanje funkcionalnih sposobnosti učenica. Istraživanje je imalo longitudinalni karakter, a eksperimentalni program je sproveden na uzorku od 97 učenica prvog razreda osnovnih škola iz Leposavića i Zvečana, kronološke starosti 7 godina ± 6 mjeseci. Uzorak je podijeljen u dijve grupe: eksperimentalna 56 i kontrolna 41 učenica. Za procjenu funkcionalnih sposobnosti učenica primjenjeno je šest mjernih instrumenata. Finalna obrada podataka uključivala je samo one ispitanice koje su sudjelovale na inicijalnom i finalnom mjerenju. Obradom podataka izračunati su osnovni statistički parametri na inicijalnom i finalnom mjerenju. Kako bi se sagledali utjecaji eksperimentalnog programa na funkcionalne sposobnosti učenica, neophodno je utvrditi postoje li eventualne razlike između učenica eksperimentalne i kontrolne grupe na inicijalnom merenju, primjenjena je multivarijantna analiza varijance (MANOVA) i univarijantna analiza varijance (ANOVA). Za utvrđivanje evantualnih razlika između inicijalniog i finalnog mjerenja primjenjene su multivarijantna i univarijantna analiza varijance za ponovljena mjerenja (MANOVA i ANOVA – repeated measures). Za utvrđivanje efekata eksperimentalnog programa primjenjene su multivarijantna analiza kovarijance (MANKOVA) i univarijantna analiza kovarijance (ANKOVA). Na temelju rezultata može se zaključiti da je posebno programirana nastava tjelesnog odgoja značajno utjecala na promjenu većine ispitivanih funkcionalnih sposobnosti učenica. Rezultate ovog rada mogu koristiti nastavnici tjelesnog odgoja jer im daju informacije o odgovarajućem planiranju i programiranju nastave.

Ključne riječi: *učenice, eksperimentalni program, funkcionalne sposobnosti, MANOVA, ANOVA*

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THE IMPACT OF MOTOR ABILITIES AND MORPHOLOGICAL CHARACTERISTICS ON THE SUCCESSFULNESS IN FREE STYLE SWIMMING

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Abstract

The aim of this research is to determine the impact of motor abilities and morphological characteristics on the successfulness in free style swimming, before and after the realization of a swimming course. The research was conducted on the sample of 90 pupils, females, age 11-12, in the fifth grade of elementary schools from the Municipality New Town, by means of 12 motor, 7 morphological variables and 1 criteria variable. By analyzing the presented results of the regressive analysis we can establish the fact that after the initial-start in measuring, among the motor variables as a whole prediction system, the most significant impact on the criteria variable OCJTEH (swimming in 25 m lap using a free technique) has to be attached to these variables: standing on the right leg horizontally on the balance bench with eyes open (MBADNU) and deep squats (MRSDCU). On the other hand, the prediction system of morphological variables has not proved to have a statistically significant impact on the criteria variable OCJTEH. After the final-ending measurement, among the motor variables as a whole prediction system, the most significant impact on the criteria variable has to be attached to these variables: deep squats (MRSDCU) and the coordination with a stick (MKOPRP). On the other hand, again, even after the final measurement, the prediction system of morphological variables has not had any significant impact on the criteria variable.

Key words: *girls, motor, morphologies, variables, influence, swimming, regression analysis*

Introduction

Pivač et al., (1995), on a sample of 87 female students aged 20-24 years were analyzed the influence of basic-motoric abilities in the learning process and the overbuilding of the techniques of sports of swimming (front crawl, back crawl, breaststroke). Based on regression analysis for successful learning sport techniques of swimming front crawl and back crawl stroke requires a good coordination, speed and flexibility of the shoulder belt and the foot in dorsal flexion and plantarnoj. When breast stroke techniques from applied basic predictor set-motor skills are only significantly affect the dimensions of flexibility in defining the criterion variable. When comparing the structure of the abilities that have an impact on the efficiency of swimming on the applied research with a sample of the swimming population, it is evident that there is no significant difference, except that in swimming the population dynamic strength has much more influence, as in the above research has not been obtained. Rađo (1998), on a sample of 109 students from the Faculty of Physical Education, male, comes to the conclusion that: "The function of success in swimming, the most contributing variables of coordination, explosive and dynamic strength, speed, flexibility and speed nerve-muscle reactions to the sight." Redžić (2004), a sample of 35 male students of physical education and sport at the University of Tuzla, conducted a research on the connection between the general and situational motor in anthropological space that is significantly expressed the results in front crawl swimming technique. The study applied five variables of general motor coordination in areas relevant to swim freestyle and four situational variables from the motor. By using regression analysis attempted to determine the size of the general impact predictor system, which is represented by a general motor rhythm in the criterion system which is opportunistic motor. At the time of swimming 50 yards front crawl technique investigated variables affecting general motor with 20% in explaining the results, while the other 80% in explaining the influence the other variables: general motor, anthropometry. That could include talk about the importance of motor abilities, morphological characteristics of these children, their learning outcome (coping) in a kinesiological activity, in this case swimming (free style), it is primarily familiar with the basic structure of movement in a given activity, and main characteristics of morphology and some motor skills and their mutual influence (Bonacin et al., 2008). Swimming as a sport or activity in general as movement specific in that it takes place in an aqueous environment, which has certain physical characteristics that greatly influence the character of human movement and motion, and thus the realization of his motor skills. In such circumstances, then the child has to be adapted so that their motor skills exhibited at the highest level possible in order to achieve the highest possible results and learned to swim as soon as possible.

Problem and objective research

Working with children at this age is very responsible, because the overall development of the child is still not finished, and therefore, because it is a beginner, this is the obligation of teachers is greater. The problem of this research is whether and to what extent the selected motor abilities and

morphological characteristics influence successful learning freestyle swimming, performed before and after the training program of swimming, the goal is to determine the influence of motor abilities and morphological characteristics on the success of learning freestyle swimming, before and performed after the training program of swimming.

Methods

The sample was homogenized by sex. So for the purposes of this study entered 90 pupils, female, aged from 11-12 years, fifth-graders from elementary schools in the Municipality of Novi Grad. All students are measured with 20 variables to well-conceived cover the motor and morphological manifestations. Selection of measuring instruments was based on standards, recommendations, and the extensive literature on the way to the measured results, it can get the most useful information on the occurrence in children. For the assessment of motor abilities was used 12 variables to well-conceived cover the area of primary motor dimensions: variable to assess coordination (agility in the air - MKOOUZ, switching the ball from hand to hand over his head - MKOPRP); variables for assessment of dynamic strength (push-ups - MRSSKL , deep squats - MRSDCU, lifting the hull from lying - MRSDTZ); variables for assessing the flexibility (lateral - MFLCSP, side pouch - MFLBSP, bend while sitting on a bench with both feet - MFLPRK), the variables for assessment of balance (standing on right leg lengthwise on the bench for balance with your eyes open - MBADNU, standing on left leg lengthwise on the bench for balance with your eyes open - MBALNU, standing on two feet lengthwise on the bench for balance with your eyes open - MBAOBN). To assess the morphological characteristics of the respondents used the 7 variables, namely: variable to assess longitudinal dimension of the skeleton (body height - AVISTJ, sitting height - ASJVIS, leg length - ADUŽNO, arm length - ADUŽRU) variables to estimate the volume and body weight (range chest - AOPGRK, body weight - ATEŽTJ, upper arm girth-prone - AOPNAD) and 1 criterion variable to assess the success of a free style swimming (Votes techniques - OCJTEH).

Table 1. Criteria for assessment

GRADE:	LEVEL OVERCOME TECHNIQUES:
5 (A)	Techniques that are implemented with an optimal angle of attack (front crawl), the proper coordination of movements with proper breathing.
4 (B)	Satisfactory performance art crawl, with small errors in terms of coordination of arm and leg.
3 (C)	Semmi-swimmer. There are obvious errors in the performance of the coordinating elements of freestyle technique, and disrupted breathing techniques.
2 (D)	Buoy. There are large errors in the execution of coordinating elements of freestyle techniques and the complete absence of breathing techniques.
1 (E)	A complete non-swimmers.

The work program was implemented in this research has been done on the principles in theory and practice which treats the methods of work with beginners. Essentially the program encompass the activity: time period (four months, stim as respondents in this period were divided into two groups of 45 students, for a period of two months per group), the number of the training unit of training: 16 hours per block group (2 times a week), duration of a block of teaching hours: 90 minutes, with the aim of determining the size of the influence of motor abilities and morphological characteristics on the success of learning freestyle swimming, performed before and after the training program of swimming (Table 1).

Table 2. Initial and final results

Initial measurements		
Ratings	Total	Percentage
1-E	41	46%
2-D	24	27%
3-C	24	27%
4-B	1	0%
5-A	0	0%
Total number: 90		
The percentage of swimmers: 27%		
The percentage of non-swimmers :		

Final measurements		
Ratings	Total	Percentage
1-E	0	0%
2-D	25	28%
3-C	31	34%
4-B	25	28%
5-A	9	10%
Total number: 90		
The percentage of swimmers: 72%		
The percentage of non-swimmers:		

Data obtained in this study were analyzed using SPSS 16.0 software package. Regression analysis was applied to determine the influence of motor abilities and morphological characteristics of students aged 11-12 years on the success of learning freestyle swimming, performed before and after the training program of swimming.

Results and discussion

Regression analysis is used to determine the influence of motor abilities and morphological characteristics, selected as the input or predictor set, the success in swimming, marked as an exit or criterion variable. On the basis of multiple regression (R) is the common variance explained (R Square) only if it is statistically significant.

Rather high coefficient of multiple correlation R = 0.857 indicates a statistically significant effect of the whole system of motor predictor variables on the criterion, which means that success in swimming can be predicted through the entire motor system predictor variables, but looking at it individually.

Table 3. Variables for as. of motor skills (initial – initial)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,86	,73	,69	,37
a. Predictors: (Constant), MKOOUZ, MFLCSF, MBAOBN, MKOPRL, MFLPRK, MRSSKL, MRSDCU, MRSDTZ, MKOPRP, MFLBSP, MBALNU, MBADNU				

Table 4. Regression analysis

	Beta	t	Sig.
MBADNU	0.41	2.96	,004**
MBALNU	0.00	0.02	,986
MBAOBN	0.01	0.10	,919
MFLPRK	-0.02	-0.24	,814
MFLCSF	0.10	0.90	,372
MFLBSP	-0.03	-0.29	,772
MRSDTZ	0.04	0.41	,682
MRSSKL	0.18	1.86	,067
MRSDCU	0.24	2.41	,018*
MKOPRP	0.03	0.29	,771
MKOPRL	0.04	0.39	,699
MKOOUZ	0.05	0.51	,609
Dependent Variable: OCJTEH			

Table 5. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	28.54	12	2	18	0.000
	Residual	10.36	77	0.14		
	Total	38.9	89			
a. Predictors: (Constant), MKOOUZ, MFLCSF, MBAOBN, MKOPRL, MFLPRK, MRSSKL, MRSDCU, MRSDTZ, MKOPRP, MFLBSP, MBALNU, MBADNU						
b. Dependent Variable: OCJTEH						

The largest and statistically significant effect on the criterion variable OCJTEH motor have the following predictor variables: - MBADNU (BETA) = 0.406, which is significant at p = 0.004 MRSDCU (BETA) = 0.241, which is significant at p = 0.018

Table 6. Variables for assessment of morphological characteristics (initial – initial)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.161	.026	-.057	.680
a. Predictors: (Constant), ASJVIS, AOPNAD, ADUŽNO, ADUŽRU, AOPGRK, AVISTJ, ATEŽTJ				

Table 7. Regression analysis

	Beta	t	Sig.
ATEŽTJ	-0.14	-0.29	,770
AVISTJ	0.34	1.09	,278
ADUŽRU	-0.24	-1.03	,305
ADUŽNO	-0.04	-0.18	,859
AOPGRK	0.17	0.60	,553
AOPNAD	0.03	0.09	,927
ASJVIS	-0.04	-0.26	,796
Dependent Variable: OCJTEH			

Table 8. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.01	7	0.15	0.3	0.946
	Residual	37.89	82	0.46		
	Total	38.90	89			
a. Predictors: (Constant), ASJVIS, AOPNAD, ADUŽNO, ADUŽRU, AOPGRK, AVISTJ, ATEŽTJ						
b. Dependent Variable: OCJTEH						

Rather low coefficient of multiple correlation R = 0.161 indicates that the predictor system of morphological variables, no statistically significant effect on the criterion variable OCJTEH (Sig. = 0.946), and the interpretation of the results will be made.

Table 9. Variables for assessment of motor skills (final – final)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.935	0.874	0.854	0.364
a. Predictors: (Constant), MKOOUZ, MFLBSP, MRSDTZ, MFLCSF, MRSSKL, MFLPRK, MBAOBN, MKOPRL, MRSDCU, MKOPRP, MBALNU, MBADNU				

Table 10. Regression analysis

	Beta	t	Sig.
MBADNU	,191	1,932	,057
MBALNU	,060	,637	,526
MBAOBN	,077	,813	,419
MFLPRK	-,016	-,313	,755
MFLCSF	-,034	-,752	,454
MFLBSP	,016	,360	,720
MRSDTZ	,016	,366	,715
MRSSKL	,098	1,862	,066
MRSDCU	,220	3,137	,002**
MKOPRP	,236	2,826	,006**
MKOPRL	,122	1,792	,077
MKOOUZ	,125	1,868	,066
Dependent Variable: OCJTEH			

Table 11. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	70.79	12	5.90	44.55	,000
	Residual	10.20	77	.13		
	Total	81.00	89			
a. Predictors: (Constant), MKOOUZ, MFLBSP, MRSDTZ, MFLCSF, MRSSKL, MFLPRK, MBAOBN, MKOPRL, MRSDCU, MKOPRP, MBALNU, MBADNU						
b. Dependent Variable: OCJTEH						

Rather high coefficient of multiple correlation R = 0.935 indicates a statistically significant effect of the whole system of motor predictor variables on the criterion, which means that success in swimming can be predicted through the entire motor system predictor variables, but looking at it individually. The largest and statistically significant effect on the criterion variable OCJTEH motor have the following predictor variables: - MRSDCU (BETA) = 0.22, which is significant at p = 0.002 - MKOPRP (BETA) = 0.236, which is significant at p = 0.006.

Conclusion

Regression analysis was applied to determine effects of motor and morphological variables on the success of learning freestyle swimming. As a criterion in this analysis was used one variable, OCJTEH (swimming section 25 m freestyle technique). Based on the presented results of regression analysis before and after implementation of swimming can be determined that there is a rather high multiple correlation coefficient of the system of motor variables and the criterion variable, which indicates that the predictor variables of the motor system has a significant influence on the criterion variable.

Based on the presented results of regression analysis before and after implementation of swimming can be determined that there is a rather low coefficient of multiple correlation system of morphological variables and the criterion variable, which points to the fact that the predictor system of morphological variables, no statistically significant effect on the criterion variable, and the reason that can be seen from a given table (Tabele 2).

Table 12. Classification based on the ABOMAI

Classification based on the ABOMAI	Initial measurement	Final measurement
Malnutrition	70%	76%
Ideal weight	28%	21%
Overweight	2%	3%
Total	100%	100%

After examining the calculated value of BMI led to the conclusion that the majority of children found in the category of malnutrition, as seen from a given table. However, it was expected, because it was a population of children who were in that age period was present accelerated growth, and slower growth. Finally we can conclude that the better results achieved those students who have developed motor skills, because they had a great influence on the criterion variable OCJTEH before and after implementation of swimming.

This is important information for those who wish to engage in training children in swimming, you know they should pay great attention to developing motor skills.

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UTJECAJ MOTORIČKIH SPOSOBNOSTI I MORFOLOŠKIH KARAKTERISTIKA NA USPJEŠNOST UČENJA SLOBODNOG STILA PLIVANJA

Sažetak

Cilj ovog istraživanja je utvrđivanje utjecaja motoričkih sposobnosti i morfoloških karakteristika na uspješnost učenja slobodnog stila plivanja, prije i nakon realiziranog programa obuke plivanja. Istraživanje je provedeno na uzorku od 90 učenika, ženskog spola, u starosnoj dobi od 11-12 godina, petih razreda iz osnovnih škola sa Općine Novi Grad, uz pomoć 12 motoričkih, 7 morfoloških varijabli i 1 kriterijske. Analizirajući prezentirane rezultate regresijske analize može se konstatirati da su nakon inicijalnog-početnog mjerenja od motoričkih varijabli kao cijelog prediktorskog sistema statistički najznačajniji utjecaj na kriterijsku varijablu OCJTEH (plivanje dionice 25 m slobodnom tehnikom) imale varijable: stajanje na desnoj nozi uzdužno na klupici za ravnotežu sa otvorenim očima (MBADNU) i duboki čučnjevi (MRSDCU). Dok prediktorski sistem morfoloških varijabli nije imao statistički značajan utjecaj na kriterijsku varijablu OCJTEH. Nakon finalnog-završnog mjerenja od motoričkih varijabli kao cijelog prediktorskog sistema statistički najznačajniji utjecaj na kriterijsku varijablu su imale varijable: duboki čučnjevi (MRSDCU) i koordinacija s palicom (MKOPRP). Dok opet i nakon finalnog mjerenja prediktorski sistem morfoloških varijabli nije imao statistički značajan utjecaj na kriterijsku varijablu OCJTEH.

Ključne riječi: *djevojčice, motorika, morfologija, varijable, utjecaj, plivanje, regresijska analiza*

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