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One, who knows where he wants to arrive, will  
not go far away. (Traditional)

/In science especially/

Dear reader,

With this issue we get into third year of journal publishing. In this turbulent times, we expect new tasks and new challenges, and among them certainly some that will greatly determine future activities of all of us. We can perceive new times that will respect science far more, where it is possible to recognize higher importance of High education legislation, Agency for Development of Higher Education, as well as other B&H institutions. Publisher of Sport Science journal – Faculty of Education from Travnik, through this activity form affirms science and scientific way of thinking, providing possibility to all interested, especially to young, to attempt themselves in scientific fields and to express ideas in sport science area – in kinesiology. As one can see, several respectable scientists joined us, so through journal now perform 70 scientists from 31 countries from all 6 continents. Alongside, journal received a new encouragement, an indexation in World bases "Genamics" among 38 linked publications of this type, but also in extremely famous "Open J-Gate" and "Electronic Journals Index (SJSU)" that are all great accomplishments. According to that, this issue is interesting, too. Methodological orientation is present through kinematics analysis of front leap, universal methodology of process identification, and analysis of handball tests reliability. Biomedicine aspect offer analysis of blood conditions, and paper about relations between strength and cardiovascular endurance. In management you can find integral approach to preventive sports management, paper about situation in sports human resources in neighborhood country, and educational aspect of micro-sociological structuring with grammar female students. Educational utility is represented with article about analysis of motor dimensions in half and full day stay of preschool children, with paper about methodical approach to teaching athletics, but also with historical review of local basketball activities. Finally, sport in narrower sense surrounds proposal of innovative judo training, karate motor dimensions, influence of flexibility on swimming, but morphological characteristics of swimmers too, analysis of footballers energetic capacities, review of latent dimensions of basketball efficiency, and differentiation of young basketball players properties. According to all mentioned we will continue our efforts, assuredly with you, to open new doors with intention to respond to challenges with quality recognized in worldwide proportions.

Editor-in-Chief  
Asst.Prof.Dobromir Bonacin, PhD

Neće daleko otići onaj koji unaprijed zna gdje  
treba stići. (Narodna)

/Naročito u znanosti/

Dragi čitatelju,

S ovim brojem ušli smo u treću godinu izdavanja časopisa. U ovim turbulentnim vremenima, pred nama su nove zadaće i novi izazovi, a među njima su sigurno i oni koji će uvelike odrediti buduće aktivnosti svih nas. Polako dolazi vrijeme kad će se još više polagati na nauku, o čemu svjedoči sve veća važnost Zakona o visokom obrazovanju, Agencije za razvoj visokog obrazovanja kao i drugih institucija u BiH. Izdavač časopisa Sport Science – Edukacijski fakultet u Travniku, i kroz ovaj vid aktivnosti afirmira nauku i naučna promišljanja, pružajući mogućnost svima zainteresiranima, a naročito mladima, da se okušaju u znanstvenim vodama i izraze se u prostoru sportske znanosti – kineziologije. Kao što se može vidjeti, još nam se mnogo uglednih autoriteta pridružilo, pa sada u časopisu djeluje čak 70 znanstvenika iz 31 države i sa svih 6 kontinenata. Usporedo s tim, časopis je dobio i novi poticaj, indeksiran je u svjetske baze „Genamics“ među 38 povezanih publikacija ovog tipa, ali također i u izuzetno pozbate "Open J-Gate" i "Electronic Journals Index (SJSU)" što je veliko priznanje. Sukladno tome, i ovaj broj donosi zanimljive priloge. Metodološka orijentacija prisutna je kroz kinematičku analizu skoka kroz vijaču, univerzalnu metodologiju identifikacije procesa, kao i analizu valjanosti rukometnih testova. Biomedicinski aspekt nudi analizu krvne slike, kao i članak o odnosu snage i kardiovaskularne izdržljivosti. U menadžmentu je moguće pronaći integralni pristup preventivnom sportskom menadžmentu, zatim promišljanja o stanju sportskih ljudskih potencijala u susjednoj zemlji, te edukacijski aspekt mikrosociološkog strukturiranja gimnazijalki. Edukacijski utilitet je zastupljen priložima o analizi motorike u dvije različite strukture boravka u predškolskoj ustanovi, zatim kroz metodički pristup nastavi atletike, ali i uz povijesni pregled lokalnih aktivnosti u košarci. Konačno, sport u užem smislu obuhvaća prijedlog inovativnog treninga u judou, zatim motorička svojstva u karateu, nadalje utjecaj fleksibilnosti na plivanje kao i morfološka svojstva plivača, analizu energetske kapaciteta nogometaša, kao i prikaz latentne strukture specifičnih akcija, ali i razlikovanje svojstava u košarci. Zbog svega rečenog, i dalje ćemo se truditi, naravno zajedno s vama, otvarati nova vrata i na spomenute izazove nastojati odgovarati kvalitetom prepoznatljivom u svjetskim razmjerima.

Glavni urednik  
doc.dr.Dobromir Bonacin

## INTEGRAL INTERACTIVE TECHNOLOGY OF TRAINING, BUSINESS AND ORGANIZATIONAL FUNCTION IN THE PREVENTIVE SPORTS MANAGEMENT OF HUMAN RESOURCES

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*Preliminary scientific communication*

### Abstract

*The aim of this paper is to construct and analyze three integral interactive models of training, business and organizational functions, created on the basis of philosophical, visionary, conceptual, scientific, technological and pragmatic approaches and projections in the preventive sports management of human resources; thus, these actions can emphasize the existentialism and continuity of integral structure of technological model of functions on the other hand, and interactive functioning of components and elements within each function on the other hand. Therefore, the most competent values of transformation system of sport will be achieved on the basis of their unity and cooperation. If a sports technological business and organizational structural system of sport can work, it is necessary that there is interactive cooperation of, on the one hand, sportspeople, coaches, experts and scientists in the training function and, on the other hand, managers, marketing managers, directors and volunteers, who are actively engaged in the organizational structure of sports clubs, associations and scientific and expert institutions in the integral and interactive way.*

**Key words:** *integral interactive technology, training, business and organizational function, preventive sports management of human resources*

### Introduction

The beginning, development and changes in the training, business and organizational function undoubtedly represent one of the most important incentives and modifications within integrative and interactive functions of sports and technology as well as in sports philosophy as a whole; also, they mean directing of individuals to their knowledge and creative potentials as the most important industrial and developing resources. It is certain that new scientific discoveries, their application and incorporation into new products, organization, services, lifestyle and management mean that change and creating of the new have become the only possible way of existentialism of organization, society and individual (Bahtijarević-Šiber, Borović, Buble, Dubajić & Kapustić, 1991; Brewser, 1993). The system of modern sport in the world achieves its goals and activities in accordance with the existing law and legal acts of their countries; moreover, it is ratified by conventions and principles determined by The European Sport Charter, Code of Sports Ethics and European Sport for All Charter of the Council of Europe as well as by sports rules which are directly applies and are valid for all who are directly or indirectly included in the responsibilities of national sports associations and who adapt their rules to the rules of international sports associations (Malacko, 2008).

#### **Preventive management – term and structure**

The term of preventive management of human resources in the sports organizations can be defined in the best way by punctual, useful and projected strategic prevention, i.e. futurist design and creation of the philosophy, vision and mission of management which are in the function of long-term continuous ontogenesis of organization.

And its essence is expressed in constructing of more optimal desired condition and development of integral, functional and interactive system of sport in the modern society. The process of organizational changes within sports organizations in all hierarchical levels is based on developing newer, more useful and more optimal strategies which result in strengthening the role of some functions. Therefore, the transformation of its certain constituents – components and elements of their philosophy, vision and mission is carried out in accordance with the requirements of environment and the needs of an organization (Certo, 1988; Lessem, 1989; Poole, 1990; Hagström, Hedlund, Chandler, Hagström & Sölvell 1998).

#### **Classification of functions of management of human resources**

The system of sport in models of structurally organized patterns can have several approaches, concepts, classifications and structures, which do not have to be institutionalized organizational units but they are formed as separate independent units. There are no determined organizational patterns in sport since every organizational unit has its specific characteristics which make it different from the others. Within sports management of human resources the following classification of integral and interactive functions is used (Malacko & Rađo, 2006):

- **Training function**, which is directed to increasing of efficiency of training, not only by increasing the labor but also by application of better organization of training, wiser working schedule and recovery along with continuous care of athlete as integral anthropological being.

It is conducted through so-called optimal managing of overall transformational process (the activities before, during and after training) by interactive activities of human resources (contestants, coaches, experts and scientists of various profiles) on the integral basis;

- **Business function**, which is directed to integral organization and interactive functioning of human resources by individuals or group of people (managers, marketing managers, directors, volunteers) who manage primary activities (before, during and after the working process) and who are responsible for material and financial conditions and means, making profits and providing good service, rational use of capacities, maintaining and development of sports facilities and equipment necessary for training functioning on the integral and interactive basis;

- **Organizational function**, which is mainly directed to integral organizational structure and interactive functioning of sports associations and expert and scientific institutions (sports clubs, associations and institutions) and it represents institutionalized form of directing and coordinating human resources by certain components (preparatory, current and controlling activities) that create and execute determined goals and have integrative and interactive role, which derives from the needs of society, sports organization and people. Such philosophical, strategic, structural and pragmatic approach in the modern integrative and interactive technology of the sports system which states that upgrading (synergism) or cooperation (interaction) of the various functions must be integrated into the mutual process in order to get better effect than the usual result of input is, should be observed through complementation as important and inseparable training, business and organizational functions which together reflect full ontological nature of preventive actions in the sports organizations (Wright, Mc Mahan, McWilliams, 1994; Malacko, 2007; Tomić, 2007).

### The aim

The aim of this paper is to construct and analyze three integral interactive models of training, business and organizational functions, created on the basis of philosophical, visionary, conceptual, scientific, technological and pragmatic approaches and projections in the preventive sports management of human resources; thus, these actions can emphasize the existentialism and continuity of integral structure of technological model of functions on the other hand, and interactive functioning of components elements within each function on the other hand. Therefore, the most competent values of global transformation system of sport can be achieved on the basis of their unity and cooperation.

### Methods

The integral and interactive functions in the preventive sports management of human resources can be defined as a set of intercorrelation and relationships between particular constituents (components and elements) in the certain technological system which they comprise.

There is not any simplified way how to define the structure of management functions, so they are usually presented as structural organized patterns, where their components, elements and their link are presented from the aspect of vertical and horizontal connection. Within the integral and interactive technologies of sports management of human resources, there are integral and interactive training, business and organizational functions.

### The construction and analysis of functions

**A. The integral and interactive function of training technology** aims to achieve more optimal efficiency of technological process and high effectiveness of achieved sports result by human resources as quickly as possible. The structure of integral and interactive function of training technology consists of the following elements:

- o **Modeling of training technology** – constituting hypothetic, phenomenological and scientific and technological hierarchical structure of the model of certain sports or sports disciplines (equations of specification);

- o **Diagnosis of sportsmen** – determining initial condition of primary anthropological features, abilities and characteristics (with the appropriate norms) of sportsmen who undergo training since the result depends on it;

- o **Planning the training process** – determining the projections, aims and tasks that are assigned to sportsmen during the certain time interval, and they are formed as the result of comparing initial state with the desired state included in the equation of specification for the certain sport or sports discipline;

- o **Programming the training content** – constructing or selecting the training moving structures (programme) and methods for implementing planned tasks within the appropriate conditions by applying adequate burden in certain macro-, mezzo- and micro-structures of the training, i.e. within time intervals;

- o **Operating the training** – achieving the plan and programme of training and regulating the training and competition in accordance with the possibilities of sportsmen and the level of their strength;

- o **Registering the training** – quantifying and registering all relevant information that are realized in the process of training and competition, and which are significant when effects of training are analyzed;

- o **Classification of training** – grouping of operated and registered list of moving structures, methods and burden as well as determining their intercorrelation and inter-dependency;

- o **Controlling the training process** – checking the dynamics of development and improving primary features, abilities and characteristics of sportsmen, which have been diagnosed and included in the training transformation process as well as by obtained and forecast sports results in the appropriate competitions;

- o **Processing the registered data** – getting the information on the significance of differences between initial, transitive and/or final condition of primary anthropological features, abilities and

characteristics of sportsmen, i.e. their structure, intercorrelation and influence on the achieved sports results by the application of adequate (univariate and/or multivariate) statistical methods;

- o **Analyzing the effect of the training** – getting the information on structural changes of anthropological status of sportsmen and achieved effects under the influence of training moving structures, methods and burden, i.e. their efficiency as well as the grade of obtained goal;

- o **Correcting the training process** – taking useful, valid and punctual corrections (the criteria of efficiency), plans, programmes and their realization on the basis of implemented control of sportsmen and analysis of efficiency of implemented training as well as on the achieved sports effects;

- o **Comparing the achieved results** – comparing the planned with realized training tasks and achieved sports results.

**B. Integral and interactive function of business technology** includes sports development, planning of general business operations in the field of sport, organizing all relevant resources, processes and functions, providing financial means, building and managing the objects and investments and so on. The structure of integral and interactive function of business technology consists of the following elements:

- o **Modeling the business technology** – creating complete approach to business technology which includes philosophy, policies, programmes, practice and processes of human resources as well as organizational and operated solutions;

- o **Diagnosis and analyzing the business** – collecting and determining basic information for operation, code of practice and successful implementation of working tasks by those who perform the task;

- o **Planning the needs of human potentials** – determining the total number of employees in the organization as well as their particular components and elements;

- o **Design of job posts selection** – describing job posts (responsibilities), determining the qualification structure and number of posts;

- o **Recruiting and selection of human resources** – collecting data and selecting people who fit into the working requirements and tasks and according to their abilities, interests and genetic potentials;

- o **Education and development of human resources** – education and training of people according to the goals and needs of organization, their wishes, interests and abilities;

- o **Improving the competence of human resources** – increasing the quality of individuals who will be able to perform tasks and operations optimally and successfully so there will be higher efficiency and effectiveness;

- o **Controlling the working process of human resources** – observing implemented programme working tasks by individuals and/or group of people who contribute to achievements of sports organization and overall success and development;

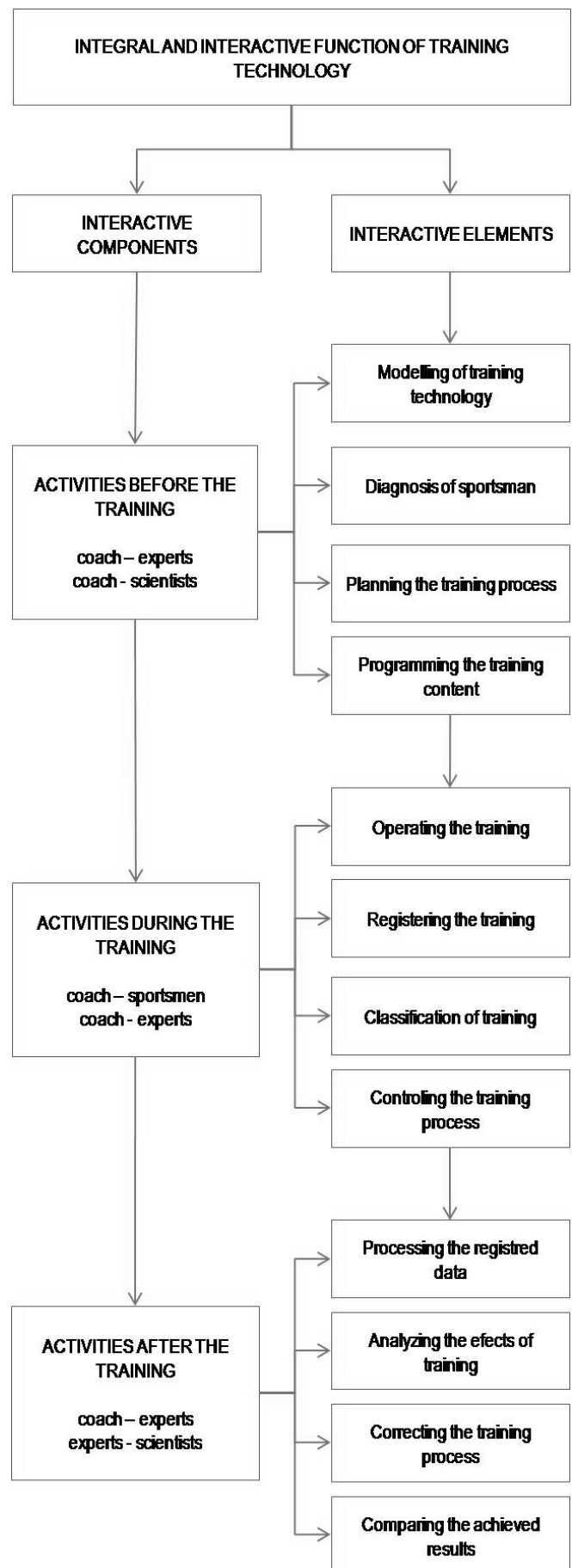


Figure 1. Integral and interactive function of training technology

- o **Compensation and awarding of human resources** – material and financial stimulation of employees in order to have more optimal functioning and higher productivity;
- o **Taking protective measures during the working process** – regulating protective measures by special legal acts which should be continuous, thorough and operationally optimal;
- o **Implementation and development of new human resources** – providing the continuity of working process in the future by new and competent people;
- o **Implementation of information system** – collecting, processing, saving, keeping and using the data in order to have more efficient functioning of policies and development of human resources.

**C. Integral and interactive function of organizational technology** includes sports organizations (club, associations) and scientific and expert institutions (faculties, institutes, centers) as parts of general social and sports system, which rely on integral environment and interrelations. The structure of integral and interactive function of organizational technology consists of the following elements:

- o **Modeling of organizational technology** – constructing of integral and interactive organizational structure of sports organizations (clubs, associations, institutions) in order to get optimal and useful functioning;
- o **Diagnosis of initial condition** – collecting the basic information about the current state and functioning in the sports organizations, associations and institutions;
- o **Predicting and constructing the desired state** – determining the future desired state in the organization function in the integrity and according to particular components and elements;
- o **Planning the projections and goals of organizational technology** – determining strategic aims, tasks and policies of development as a whole as well as finding the most optimal variant of their realization through the certain time period (what, where, when and who should do something in the future);
- o **Managing the organizational technology** – translating the organizational function into new formed state where efficiency of functioning of the system should be taken into consideration because the optimal solutions of the parts does not have to be in accordance with the optimum of the whole;
- o **Organizing the operated function** – establishing the relationships within the organizational function by getting them involved in the process of collecting, allocation, applying and replacing the organizational resources with the final aim of constructing this working organization which consists of efficient structure of the authority on the one hand, and communication channels;
- o **Coordinating and adjusting the functions** – making sure that components and elements are in the right order and related in the way that has crucial significance for successful implementation of coordination of participants during performing the task;

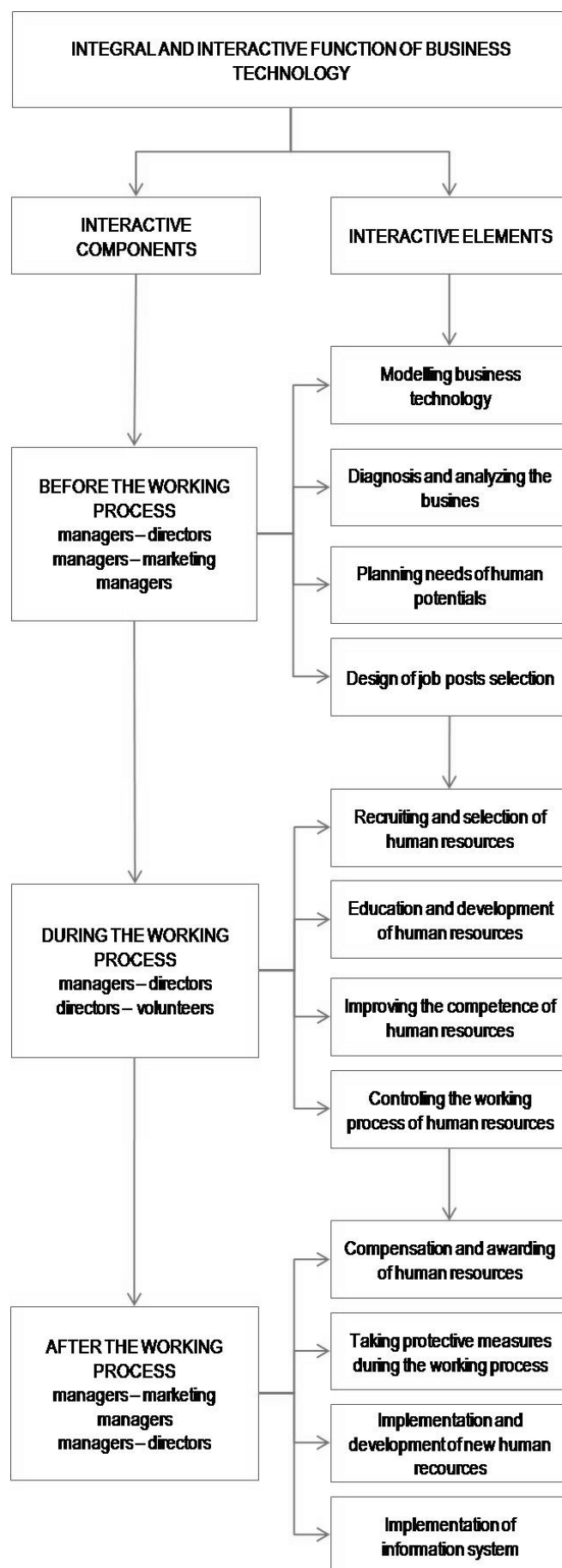


Figure 2. Integral and interactive function of business technology

Hence, some decisions that are not so strategic but operational in nature should be made;

- o **Cooperation within the organizational function** – cooperation of human resources among sports clubs, associations and expert and scientific institutions;

- o **Analyzing the handling of technology** – determining the way of managing and coordinating human resources that are directed to achieving the aim, communication, motivation and troubleshooting as the most important elements of running the organization;

- o **Controlling the accomplished goals and tasks** – monitoring the real events, determining operational plans, analyzing the conditions and changes, defining new goals, looking for the most optimal solutions and decisions, control of decision-making and comparing them with those that have previously been made;

- o **Deciding about choice and taken actions** – making decisions about the choice and functioning of one of more taken actions in order to gain previously set goal since not all the actions require the same method of decision-making, bearing in mind that the data about the goals (what we want to achieve) and actions (what is likely to be achieved) are necessary;

- o **Assessing the achieved efficiency of technology** – results from the process of managing by implementing particular elements (predictions, planning, organizing, coordinating, manipulating, deciding and controlling etc) which are directly and/or indirectly connected with integral efficiency of organizational technology in order to achieve previously planned goal.

## Conclusion

Since human resources along with their genetic and working potentials have, as basic representatives of overall operations in all segments of the development of society, the central position and role in the process of social reproductions, it can be concluded that they should also have the leading role within preventive sports management of human resources by implementing presented well-developed integral and interactive working technology (training, business and organizational function) because the competent technologists (coaches, experts, scientists), management (managers, marketing managers, volunteers) and organizers (in the sports clubs, associations and institutions) are basic creators and executors of reforms, development and progress.

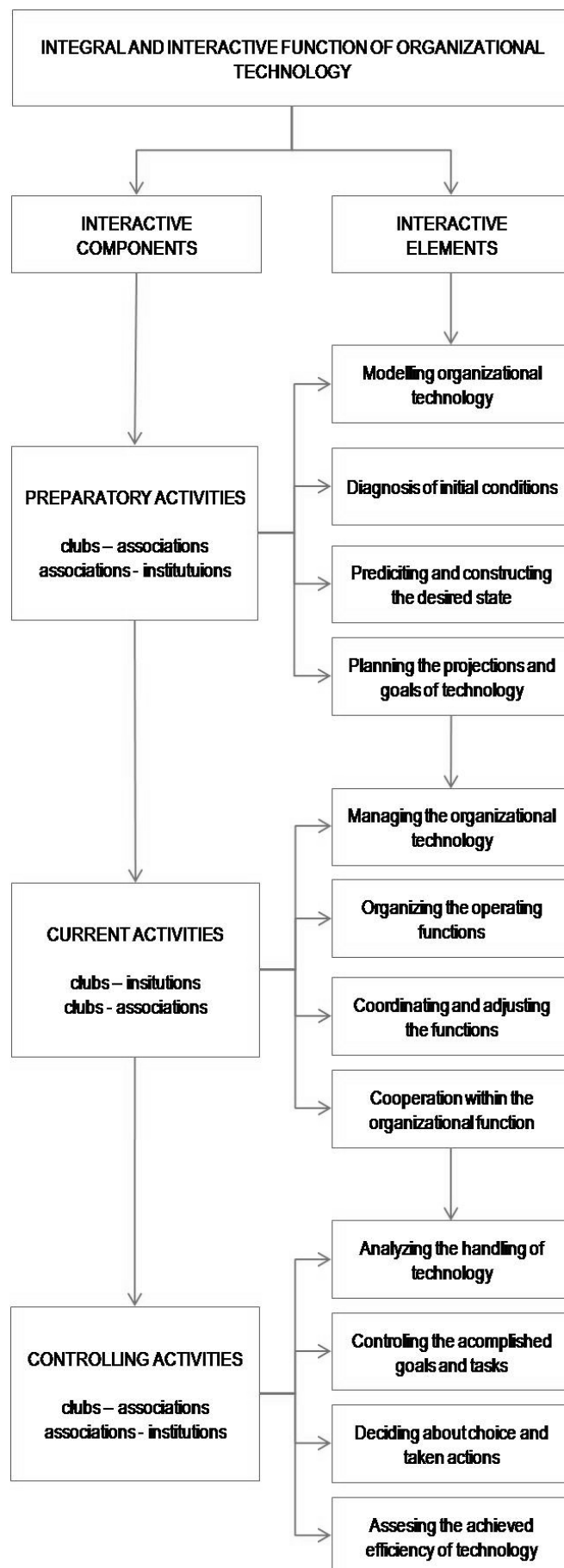


Figure 3. Integral and interactive function of organizational technology

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## INTEGRALNO INTERAKCIONA TEHNOLOGIJA TRENAŽNE, POSLOVNE I ORGANIZACIONE FUNKCIJE U PREVENTIVNOM SPORTSKOM MENADŽMENTU LJUDSKIH RESURSA

### Sažetak

Cilj rada je da se putem konstrukcije tri pojedinačna integralno interakcijska modela trenažne, poslovne i organizacijske funkcije, koji su kreirani na temeljima filozofskih, vizionarskih, koncepcijskih, naučnih, tehnoloških i pragmatičnih pristupa i projekcija u preventivnom sportskom menadžmentu ljudskih resursa ukaže, s jedne strane, na egzistencijalnost i kontinuiranost integralne strukture tehnoloških modela funkcija, a s druge strane, na interakcijsko funkcioniranje komponenti i elemenata unutar svake funkcije, kako bi se na osnovama njihovog jedinstva i kooperativnosti mogle ostvarivati najkompetentnije vrijednosti transformacijskog sistema sporta. Da bi sportsko-tehnološki, poslovno-upravljački i organizaciono-strukturalni sistem sporta mogao funkcionirati u kontinuitetu, neophodno je da postoji interakcijska suradnja, s jedne strane između sportista, trenera, tima stručnjaka i naučnika u trenažnoj funkciji, a sa druge strane, između menadžera, marketing menadžera, upravljača i volontera u sportu, koji su kroz trenažnu i poslovnu funkciju na integralan i interaktivan način aktivno usmjereni i angažirani u organizacijskoj funkciji sportskih klubova, sportskih udruženja, sportskih asocijacija i stručnih i naučnih institucija.

**Ključne riječi:** integralno interakciona tehnologija, trenažna, poslovna i organizaciona funkcija, preventivni sportski menadžment ljudskih resursa

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## COMPARATIVE KINEMATICS ANALYSIS OF DIFFERENT SPLIT FRONT LEAPS

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### Abstract

**Introduction:** The rhythmic gymnastics (RG) is a high leap demanding sport (Hutchinson et al., 1998). Leaps are fundamental human movements that require complex motor coordination of both upper and lower body segment. To make it all more interesting and complex, RG leaps performance is almost always followed by a requisite manipulation (the ball, the rope, the hoop, the ribbon, the clubs), and that manipulation is referred to requisite throws or passing through it. In spite of the growing popularity of this Olympic sport, there is a lack of biomechanical analyses in literature, regarding the techniques of rhythmic gymnastics. **Aim:** The aim of this study was to determine the difference in the certain kinematics parameters, between two types of the leaps, i.e., the front split leap, with the trunk bended backward, and both legs implied in the take off, after the stationary position and front split leap, with the trunk bended backward, and one leg implied in the take off, after the running, which could have an impact on the retention of well-defined "split" form. **Method:** The study included one subject - Evgenia Olegovna Kanaeva, Russian rhythmic gymnast, actual world champion, the only one in the history of the rhythmic gymnastics, who managed to win six gold medals at the World Championship. The sample of variables consisted of the following kinematics parameters in both types of the leaps: trajectory of the center of gravity of the body (CG) in X and Y axis and the resultant velocity ( $V_r$ ) of the CG. The data were obtained in the digitizing process, by using the software for kinematics analysis (Hum-an™, Version 5.0, 2005 HMA Technology Inc., Canada). The basic descriptive parameters and statistical significance of differences were determined by using the SPSS 12.0, statistical program for data processing. **Results:** The absolute frequencies in the  $V_r$  of the CG, showed the normal distribution in absolute values of the  $V_r$ , in the split front leap, with the trunk bended backward, and one leg implied in the take off, after the running. T-test showed that there was no statistically significant difference ( $p=.186$ ) in arithmetic mean values in the  $V_r$  of the CG, between both leaps, but a statistically significant correlation in the  $V_r$  of the CG in the flight phase was determined, in both split leaps ( $r=.658$ ,  $p=.002$ ). **Conclusion:** The split front leap, with the trunk bended backward, and both legs implied in the take off, after the stationary position, because of its mentioned characteristics, can be considered as energy demanding and more risky for injuries, due to the excessive velocity at the moment of the landing, and with justified greater difficulty in relation to the split front leap, with the trunk bended backward, and one leg implied in the take off, after the stationary position (0.1 point more).

**Key words:** rhythmic gymnastics, kinematics analysis, front leaps, comparison

### Introduction

The rhythmic gymnastics (RG) is a high leap demanding sport (Hutchinson et al., 1998). Leaps are fundamental human movements that require complex motor coordination of both upper and lower body segment (Ashby & Heegaard, 2002). To make it all more interesting and complex, RG leaps performance is almost always followed by a requisite manipulation (the ball, the rope, the hoop, the ribbon, the clubs), and that manipulation is referred to requisite throws or passing through it. Above the requisites, arm swing plays important role, which was reported in certain studies, at least when speaking about vertical jump (Ashby & Heegaard, 2002). Doubtlessly, the rhythm is also important for the harmonious execution of various complex movements (Horvatin-Fučkar, 2005). In spite of the growing popularity of this Olympic sport, there is a lack of biomechanical analyses in literature, regarding the techniques of rhythmic gymnastics (Cicchella, 2009). Nevertheless, the most part of RG coaches have a great difficulty to analyze the most common errors in the leaps execution (Sousa & Lebre, n.d.).

That is essential, because during the flight phase gymnasts perform various technical figures, which are evaluated depending on weight level (Federation Internationale de Gymnastique, n.d.). The FIG point's code defines many different jumps, but the most preferred is the split leap. A proper leap refers to elements of body movements in certain dynamic poses in the unsupported position (the flight), after the takeoff from one or both legs]. There is a difference between jumps and leaps from one or both legs. The takeoff power (mainly upward) is directed by the leaps, therefore more often, a gymnast performs the take off with both legs. That is why; the body flight trajectory is steep. However, gymnasts usually choose to leap by taking off from one leg and swinging with the other leg, and in such leaps, the body flight trajectories are much more curved (Jastržemskaia & Titov, 1998). RG leaps have three phases: the preparatory (the takeoff), the main (the flight) and the finishing (the landing). The distribution of the gymnast's attention during each phase of jumping and leaping is not equal.

The attention is higher during the approach and the flight and lower during the takeoff and the landing]. This is because a better preparatory phase helps the gymnast in better control of her movements during flight. She usually takes off and lands automatically, without a great agitation (Jastrjambaskaia & Titov, 1998). The preparatory phase is actually divided into two parts: the preliminary subphase and the takeoff subphase. The preliminary subphase begins with a semisquat before the takeoff. To increase the height of the leap, the gymnast can use a vertical jump before the semisquat. During the semisquat, the gymnast should press her heel very fast into the floor (in an elastic manner), in order to quickly transfer her body weight. The body weight transfer through the heel, during the takeoff produces high elevation. Also, in the preparatory phase, various dance steps can be used (such as the gallop or the polka), the running, and the vertical jumps. Assuredly, the approach velocity influences the power of the takeoff. In RG, the best approach is of average intensity. In any case, the gymnast finishes the preliminary subphase with a semisquat, during which the muscles are spread, and ready for active contraction in the takeoff subphase. Certainly, the semisquat is very important. Indeed, the height of the jump or the leap depends on the depth of the semisquat. By increasing the depth of the semisquat, up to the optimal value, gymnast increases the height of the jump or the leap, although excess semisquat decreases the resulting height. The most important factor in semisquat depth is the angle of the knee articulations – the optimal semisquat depth is  $112^\circ$  (variations  $\pm 20^\circ$  reduce the resulting height). Semisquat depth also depends on the strength of the leg flexor muscles. The takeoff subphase gives to the gymnast's center of gravity a vertical speed. As the speed is greater, it causes a greater the flight's height. The takeoff begins with a change in the angle of the hip articulations, followed by knees, and finally ankles.

The foot leaves the floor, starting with the heel and finishing with the tips of the toes. At this very moment, the gymnast has to straighten her legs and stretch her toes. It's necessary to focus the efforts on the foot, because strong foot muscles, help create strong takeoffs. Thus, the jump's height depends on the strength and elasticity of the leg muscles, the foot, the knee ligaments, and the Achilles tendon. A great leap requires a precise, strong and quick takeoff in the right direction. The efficiency of the leap depends on the leg and the arm coordinating movements. In fact, the arms are the "wings", which help gymnast in increasing the effectiveness of the takeoff (more demanding leap, needs stronger arm swing). Moreover, the trunk position is very important and high demanding leaps require tightened back muscles, especially in the lower back (Jastrjambaskaia & Titov, 1998). RG encompasses two main kinds of the takeoff: the takeoff from two legs and the takeoff from one leg, while swinging the other. The flight phase: As mentioned, duration and the height of the flight are mainly determined by the takeoff subphase.

However, the shape of the leap, also affects the height. The flight duration of high leaps is close to 0.5 s. By knowing the time of the flight, it is possible to calculate the increase in the height of the gymnast's center of gravity:

$$H = \frac{1}{2} \cdot g \cdot t^2,$$

where H is the height of elevation (in meters), g is the acceleration due to the gravity (in  $m/s^2$ ), and t is the time taken to rise (in seconds). As can be seen from the formula, a large flight height results from a lengthy duration of the rising. That, in turn, results in a greater flight time and a correspondingly greater opportunity for the gymnast to establish wanted pose during the flight. During this phase, a gymnast reaches a necessary shape at first, and then prepares for landing. Duration of the shape depends on the duration of the flight and the time taken to reach the pose. The less time is lost in reaching the pose, there is a more time for demonstrating this shape in the flight, which is the thing evaluated by judges. The time taken to reach the pose can only be reduced by increasing the velocity of the center of the gravity at the takeoff (Jastrjambaskaia & Titov, 1998).

The finishing (the landing) phase: The purpose of this leap's phase is to decrease the speed of the gymnast's movements. Stability during the landing depends upon the trajectory of the gymnast's body during the flight, and also the gymnast's ability to correct an inaccurate landing with her arms, head and trunk movements, and by using her leg muscles strength. Of course, poor landing technique and hard floors increase the load on the gymnast's musculoskeletal system. The gymnast should achieve the soft and the silent landing by rolling from her toes to her heels, and by gently bending in knee articulations, followed by quick straightening in knee articulations. In this way, a good landing reduces the negative acceleration arising at the moment of floor contact and eases the abrupt impact. It is easier to land on the both legs in a semisquat than to land on the single leg. It comes as no surprise, the fact that the landing phase represents the greatest risk of injury in the leap (it is thought that 34% of all gymnasts' injuries occur during the landing). That's why it is necessary to teach gymnasts to pay attention to the sounds of the landing (heavy landing indicates poor absorption of the force, made in the impact moment between the foot and the floor). There are several methods for classifying the jumps and the leaps in the RG, and the most common are based on describing the takeoff and the landing, and on analyzing the pose during the flight phase. The rhythmic gymnasts use most commonly one of three poses during the flight: the split position, the ring position and the stag position. The split position requires the following (Jastrjambaskaia & Titov, 1998): legs are apart and aligned with each other; the legs are horizontal to the floor, legs are straightened in the knee articulations; the fixed-split position during flight, allowing clear evaluation of the split position; the vertical trunk position. The front split leap is the main leap in the split group.

This leap implies the one leg take off and the swinging with another leg, while moving up and forward. During the flight, a gymnast demonstrates the split pose and reaches the horizontal position. During the takeoff, her trunk is slightly inclined forward, but straight during the flight, but there are also variations (the trunk bended backward). Gymnast lands on her swinging leg. This leap may also be performed by taking off from both legs. Within each group of the leaps, the difficulty is determined by the body element, and in order to be recognized, the difficulty has to be performed, conjointly, with requisite's element of mastership (with or without ejection of the requisite) and without technical errors. There are following levels of the difficulty: A=0.10, B=0.20, C=0.30, D=0.40, E=0.50, F=0.60, G=0.70, H=0.80, I=0.90, J=1.00 or more (Federation Internationale de Gymnastique, n.d.).

All the difficulties should have the following characteristics: the sufficient height, i.e., the elevation (necessary in the flight phase, to achieve and keep, well defined form of the leap); kept and well defined form during the flight; well amplitude; requisite's element of mastership. In order to gymnast in the competition perform all the provided elements in the best way, it is necessary that, at least 60 minutes before the competition, dedicate to the warm up, i.e., the slow running, the rhythmic steps and the leaps (Guidetti et al., 2009). This research represents the analyses of the front split leap, with the trunk bended backward, and both legs implied in the take off, after the stationary position (G difficulty – 0.70), as well as the front split leap, with the trunk bended backward, and one leg implied in the take off, after the running (F difficulty – 0.60). The data were obtained by using the kinematics method (Bubanj, S. et al., 2009). The leaps were performed by the actual World Champion Evgenia Kanaeva (RUS), during the 29-th World Championship in Japan, 2009, in the exercise with the rope. The subject of the research is a detailed analysis of two different split leaps, which differ in the preparation for the leap, the way of the takeoff, and in handling with the requisite - the rope (presence or absence of the arms' swing). The aim of this study was to determine the difference in the certain kinematics parameters, between two mentioned types of the leaps, which could have an impact on the retention of well-defined "split" form.

## Methods

The study included one subject - Evgenia Olegovna Kanaeva, Russian rhythmic gymnast (born 02.04.1990., body weight 42 kg and body height 168 cm), actual world champion, the only one in the history of the rhythmic gymnastics, who managed to win six gold medals at the World Championship. She is considered, as the best rhythmic gymnasts in the history (Wikipedia the Free Encyclopedia, n.d.). Video recordings of the actual champion performing the leaps were downloaded from the Internet (YouTube, 2009).

The sample of variables consisted of the following kinematics parameters in both types of the leaps: trajectory of the center of gravity of the body (CG) in X and Y axis and the resultant velocity ( $V_r$ ) of the CG. The data were obtained in the digitizing process, by using the software for kinematics analysis (Hu-m-an™, Version 5.0, 2005 HMA Technology Inc., Canada). Scale, necessary for the digitizing process was determined by the knowledge of the subject's body height. The basic descriptive parameters and statistical significance of differences were determined by using the SPSS 12.0, statistical program for data processing.

## Results

The split front leap, with the trunk bended backward, and both legs implied in the take off, after the stationary position (G difficulty – 0.70), is characterized by (in this specific case), arms swing (the extension in the shoulder articulations up to 180°), with dropping of one end of the rope. The leap had three phases: the takeoff (Fig. 1), the flight (Fig. 2) and the landing (Fig 3). From the moment of the takeoff up to the landing, elapsed time was 0.57s, i.e. video record was divided in to 36 frames (null + 35), which means that between two adjacent frames elapsed 0.016s.



Figure 1. The moment of the takeoff (6. frame) and also, the first peak of the resultant velocity of the CG.



Figure 2. The moment of retention of the form (16. frame).

Graph 1, shows the trajectory of the CG in X and Y axes. There is a plateau in vertical direction of gymnast's CG, from 12. to 14. frame, in duration of 0.048s (from 0.21s to 0.24s). There are two peaks in the resultant velocity of the split front leap, with the trunk bended backward, and both legs implied in the take off (Graph 2).

The first peak occurred in the 6. frame – in the moment of the takeoff, with the velocity of 2.7 m/s, while the second peak occurred in the 24. frame – in the moment of the landing, with the velocity of 3.1 m/s.



Figure 3. The moment of landing and also, the second peak of the resultant velocity (24. frame).

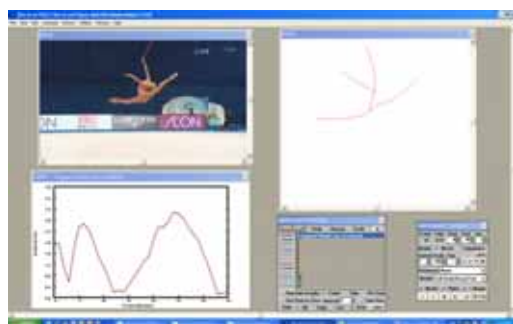
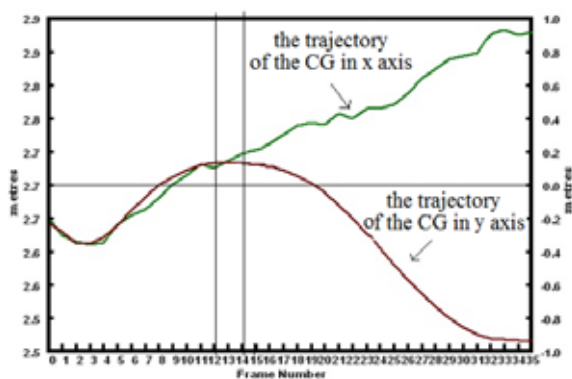
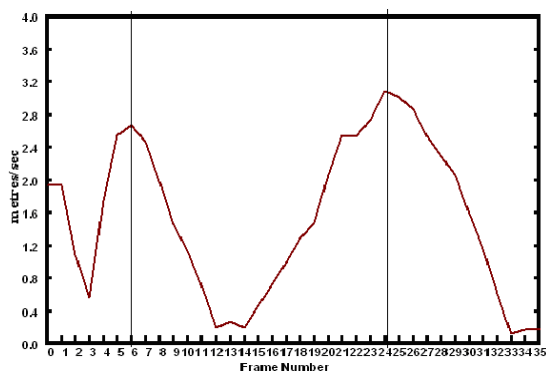


Figure 4. The split leap with both legs implied in the takeoff, after the digitalization.



Graph 1. Trajectory of the CG in X and Y axes.



Graph 2. The first and the second peak in the Vr of CG (6. and 24. frame, respectively).



Figure 5. The moment of the takeoff (10. frame) and also, the first peak of the resultant velocity of the CG.



Figure 6. The moment of retention of the form (21. frame).



Figure 7. The moment of landing and also, the second peak of the resultant velocity (25. frame).

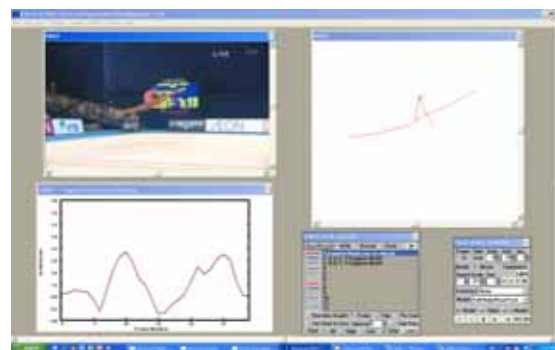


Figure 8. The split leap with one leg implied in the takeoff, after the digitalization.

Table 1 shows the values of the Vr, during the split front leap, with the trunk bended backward, and both legs implied in the take off.

Table 1. The values of the Vr.

| Frame № | Vr (m/s) |                              | Frame № | Vr (m/s) |                           |
|---------|----------|------------------------------|---------|----------|---------------------------|
| 0       | 1.931645 | The preparation for the leap | 18      | 1.294273 | The flight                |
| 1       | 1.931645 |                              | 19      | 1.479225 |                           |
| 2       | 1.080239 |                              | 20      | 2.060119 |                           |
| 3       | 0.568849 |                              | 21      | 2.546657 |                           |
| 4       | 1.750705 |                              | 22      | 2.528262 |                           |
| 5       | 2.549806 |                              | 23      | 2.740603 |                           |
| 6       | 2.677057 | The moment of the takeoff    | 24      | 3.088257 | The moment of the landing |
| 7       | 2.464588 | The flight                   | 25      | 3.016689 | The phase of the landing  |
| 8       | 1.991826 |                              | 26      | 2.865460 |                           |
| 9       | 1.462125 |                              | 27      | 2.534489 |                           |
| 10      | 1.140194 |                              | 28      | 2.290953 |                           |
| 11      | 0.712612 |                              | 29      | 2.065069 |                           |
| 12      | 0.197419 |                              | 30      | 1.590917 |                           |
| 13      | 0.196226 |                              | 31      | 1.163819 |                           |
| 14      | 0.195828 |                              | 32      | 0.610709 |                           |
| 15      | 0.467675 | The form                     | 33      | 0.122928 |                           |
| 16      | 0.733103 |                              | 34      | 0.170085 |                           |
| 17      | 0.996092 |                              | 35      | 0.170085 |                           |

Table 2. The values of the Vr of the CG.

| Frame № | Vr (m/s) |                              | Frame № | Vr (m/s) |                          |
|---------|----------|------------------------------|---------|----------|--------------------------|
| 0       | 0.901332 | The preparation for the leap | 15      | 0.227537 | The flight               |
| 1       | 0.901332 |                              | 16      | 0.241624 |                          |
| 2       | 1.019661 |                              | 17      | 0.521225 |                          |
| 3       | 0.956211 |                              | 18      | 0.665130 |                          |
| 4       | 0.961941 |                              | 19      | 0.878769 |                          |
| 5       | 0.706121 |                              | 20      | 1.304916 |                          |
| 6       | 0.321777 |                              | 21      | 1.781962 | The form                 |
| 7       | 0.981252 |                              | 22      | 1.539379 | The flight               |
| 8       | 1.660209 |                              | 23      | 1.694525 |                          |
| 9       | 2.111369 |                              | 24      | 2.036984 |                          |
| 10      | 2.275251 | The moment of the takeoff    | 25      | 2.198236 | The phase of the landing |
| 11      | 1.945712 |                              | 26      | 2.022314 | The phase of the landing |
| 12      | 1.387216 |                              | 27      | 1.290518 |                          |
| 13      | 1.189276 |                              | 28      | 0.815545 |                          |
| 14      | 0.675492 |                              | 29      | 0.815545 |                          |

Table 3. Duration of the flight phase and values of the Vr of the CG, in both type of the leaps, from the moment of the takeoff to the moment of the landing.

| Frame № | The beginning | The resultant velocity of the split leap from | The resultant velocity of the split | The beginning | Frame |
|---------|---------------|-----------------------------------------------|-------------------------------------|---------------|-------|
| 6       | 0.11          | 2.677057 <sup>1</sup>                         | 2.275251 <sup>1</sup>               | 0.18          | 10    |
| 7       |               | 2.464588                                      | 1.945712                            |               | 11    |
| 8       |               | 1.991826                                      | 1.387216                            |               | 12    |
| 9       |               | 1.462125                                      | 1.189276                            |               | 13    |
| 10      |               | 1.140194                                      | 0.675492                            |               | 14    |
| 11      |               | 0.712612                                      | 0.227537                            |               | 15    |
| 12      |               | 0.197419                                      | 0.241624                            |               | 16    |
| 13      |               | 0.196226                                      | 0.521225                            |               | 17    |
| 14      |               | 0.195828                                      | 0.66513                             |               | 18    |
| 15      |               | 0.467675                                      | 0.878769                            |               | 19    |
| 16      | 0.27          | 0.733103 <sup>2</sup>                         | 1.304916                            |               | 20    |
| 17      |               | 0.996092                                      | 1.781962 <sup>2</sup>               | 0.35          | 21    |
| 18      |               | 1.294273                                      | 1.539379                            |               | 22    |
| 19      |               | 1.479225                                      | 1.694525                            |               | 23    |
| 20      |               | 2.060119                                      | 2.036984                            |               | 24    |
| 21      |               | 2.546657                                      | 2.198236 <sup>3</sup>               | 0.42          | 25    |
| 22      |               | 2.528262                                      | 2.022314                            |               |       |
| 23      |               | 2.740603                                      | 1.290518                            |               |       |
| 24      | 0.4           | 3.088257 <sup>3</sup>                         | 0.815545                            |               |       |

<sup>1</sup> – the moment of the takeoff, <sup>2</sup> – the moment of retention of the form, <sup>3</sup> – the moment of the landing

Table 4. Descriptive parameters of the Vr from the moment of the takeoff to the moment of the landing in both types of the leaps.

| Vr (m/s)  | The split leap from the stationary position | The split leap from running |
|-----------|---------------------------------------------|-----------------------------|
| N (frame) | 19                                          | 19                          |
| Mean ± SD | 1.529 ± 0.963                               | 1.299 ± 0.658               |
| Min       | 0.20                                        | 0.23                        |
| Max       | 3.09                                        | 2.28                        |

Table 5. The sign. of difference in the Vr of the CG, between the split front leap, with both legs implied in the take off, after the stat. pos., and the split front leap, with one leg implied in the take off, after the running.

| The split leaps |                                           | Paired Differences |       |        |                |        | t     | df | Sig. |
|-----------------|-------------------------------------------|--------------------|-------|--------|----------------|--------|-------|----|------|
|                 |                                           | Mean               | SD    | S.E.M. | 95% Confidence |        |       |    |      |
|                 |                                           |                    |       |        | Lower          | Upper  |       |    |      |
| Pair 1          | from the stationary -<br>from the running | .229               | 0.726 | 0.1665 | -.12072        | .57877 | 1.376 | 18 | .186 |

Table 6. The correlation significance in the Vr of the CG in the flight phase in both split leaps.

|        |                                        | N  | Correlation | Sig. |
|--------|----------------------------------------|----|-------------|------|
| Pair 1 | from the stationary - from the running | 19 | .658        | .002 |

In the moment of the takeoff (frame 6), gymnast's CG was moving at the velocity of 2.68 m/s; in the moment of retention of the form (frame 16), the CG was moving at the velocity of 0.73 m/s; in the moment of the landing (frame 24), the CG was moving at top velocity (3.09 m/s). The split front leap, with the trunk bended backward, and one leg implied in the take off, after the running (F difficulty – 0.60), is characterized by (in this specific case), arms swing (full circle in the sagittal plane) and passing through the rope, with backward rotation. The leap had three phases: the takeoff (Fig. 5), the flight (Fig. 6) and the landing (Fig 7). From the moment of the takeoff up to the landing, elapsed time was 0.46s, i.e. video record was divided in to 29 frames (null + 28), which means that between two adjacent frames elapsed 0.016s. Graph 3, shows the trajectory of the CG in X and Y axes. There is a plateau in vertical direction of gymnast's CG, from 15. to 16. frame, in duration of 0.032s (from 0.26s to 0.27s). There are two peaks in the resultant velocity of the split front leap, with the trunk bended backward, and one leg implied in the take off (Graph 4). The first peak occurred in the 10. frame – in the moment of the takeoff, with the velocity of 2.3 m/s, while the second peak occurred in the 25. frame – in the moment of the landing, with the velocity of 2.2 m/s. The Table 2 shows the values of the Vr, during the split front leap, with the trunk bended backward, and one leg implied in the take off. In the moment of the takeoff (frame 10), gymnast's CG was moving at top velocity of 2.28 m/s; in the moment of retention of the form (frame 21), the CG was moving at the velocity of 1.78 m/s; in the moment of the landing (frame 25), the CG was moving at the velocity of 2.19 m/s. In order to test the difference in the Vr of the CG in two split leaps with different preparatory and takeoff subphases, it is necessary at first, to equal these jumps. Namely, both leaps have identical flight phase (the period from the takeoff by the time of impact with the ground), if we exclude the different arms swing, as well as various manipulation with the rope. In this way, the comparison of the leaps, from the moment of the identical flight phase is allowed. Table 3 shows the absolute values of the velocity of the CG, from the moment of the takeoff, up to the landing, as well as the duration of the phases of flight, after their equalization. Table 4 shows the basic descriptive parameters in the Vr of the CG, during the flight phase, in both split leaps.

There is a greater average resultant velocity of the gymnast's CG in the split leap from the stationary position. There is almost no difference in the minimum velocity values in both leaps, while a greater value in the maximum velocity was achieved in the split leap from the stationary position. Absolute frequencies in the Vr of the CG are shown in the histograms 1 and 2, where the normal distribution in absolute values of the Vr is obvious in the split front leap, with the trunk bended backward, and one leg implied in the take off, after the running. T-test (Table 5) showed that there was no statistically significant difference ( $p=.186$ ) in arithmetic mean values in the Vr of the CG, between both leaps, but a statistically significant correlation (Table 6) in the Vr of the CG in the flight phase was determined, in both split leaps ( $r=.658$ ,  $p=.002$ ).

## Discussion and conclusion

Kinematics of analyzed split leaps in the RG was presented on the basis of the results of one subject, the top rhythmic gymnast. Two split leaps, different in the preparation and takeoff phase and in arms swing during the flight phase, were described and compared. Kinematics analysis showed notably, normal distribution in absolute values of the Vr in the split front leap, with the trunk bended backward, and one leg implied in the take off, after the running, but greater individual values of the Vr in the split front leap, with the trunk bended backward, and both legs implied in the takeoff, after the stationary position.

Also, in the first mentioned leap, the flight phase lasted longer; the desired form was obtained earlier, and was sustained longer in relation to the time (which is one of the requirements for the recognition of the leap's difficulty). At the end of the twentieth century, the authors from Portugal (Sousa & Lebre, n.d.), analyzed biomechanically, the split front leap, with and without the trunk bended backward, in the top 12 rhythmic gymnasts, aged  $15\pm 3.2$  years (Mean $\pm$ St.dev.), body weight  $49.4\pm 4.7$  kg (Mean $\pm$ St.dev.) and body height  $167.2\pm 6.8$  cm (Mean $\pm$ St.dev.). The leaps were analyzed by using the Peak 5 - Motion Measurements System. The results showed significantly greater value of the average velocity of the CG, at the moment of the takeoff, but similar values of the velocity at the moment of the landing.

The authors, among other, concluded that the leap without the trunk bended backward, as simpler, showed lesser achieved values, because the gymnasts were less concentrated and invest less effort, when performing simple and less demanding leaps. Author Cicchella (2009), carried out the kinematics analysis of four leaps in the RG and among others of split front leap, without the trunk bended backward, in the national champions of average age 16 years, body weight 50 kg and body height 173 cm. The leaps were recorded and analyzed by using automated analytical system of movement with six cameras (Vicon 460, Oxford Metrics, UK). The obtained research results showed, the longer duration of the flight phase (0.77 s), compared to the values obtained in this our (0.57 s), although the leap was less difficult. In the study of Di Cagno et al. (2009), the authors compared 24 gymnastics (12 men and 12 women, aged  $22 \pm 4$  years, Mean $\pm$ St. Dev.), while performing the three different technical leaps: 1) split leap with legs spread; 2) Kozak with the rotation of  $180^\circ$ ; 3) Jeté with turn. The gymnasts of the masculine sex, compared to the gymnasts of the feminine sex, had a greater height of the leaps (plateau) and greater contact duration of the takeoff leg with the ground, but in the elastic properties of the muscles, between the sexes, there was no difference. In conclusion, the authors noted that in the gymnastics selection process, coaches should focus on the neuromuscular parameters and elastic properties of the leg muscles, in future gymnastics. In their earlier research, mentioned authors di Cagno et al. (2008), attempted to establish the determinant parameters of success, between 25 gymnasts (top and those with less success), which involved the anthropometric characteristics, three types of the vertical jumps and three types of the technical split leaps.

In conclusion, authors noted a statistically significant difference ( $p < 0.05$ ) in the body height ( $1.65 \pm 0.03$  m vs.  $1.55 \pm 0.09$  m, Mean $\pm$ St. Dev.) and the body weight ( $42.42 \pm 0.03$  kg vs.  $35.84 \pm 5.66$  kg, Mean $\pm$ St.Dev.) and in the technical split leaps, in favor of the top gymnasts, whereas in the vertical jumps, there was no significant difference between the groups. In the research of Dyhre-Paulsen (1987), the author found that the subjective assessment of experienced judges, who assesses the skills in the split leap of the gymnastics, positively correlated with minimal flexion in the knee articulation, during the landing phase.

Maximum flexion in the knee articulation, on the contrary, negatively correlated with grade ( $p < 0.0002$ ). It was also found, in more talented gymnastics, compared to the less talented, an earlier contraction of muscles tibialis anterior and gastrocnemius, with shorter periods of activities and longer breaks between the activities. The split front leap, with the trunk bended backward, and both legs implied in the take off, after the stationary position, because of its mentioned characteristics, can be considered as energy demanding and more risky for injuries, due to the excessive velocity at the moment of the landing, and with justified greater difficulty in relation to the split front leap, with the trunk bended backward, and one leg implied in the take off, after the stationary position (0.1 point more). The current results were obtained by using only kinematical method, and in the terms of the top competition. The comprehensive analysis requires a multidisciplinary approach, which would involve the application of the electromiographical method, the tensiometric platform and the laboratory conditions.

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## KOMPARATIVNA KINEMATIČKA ANALIZA DALEKOVISOKOG SKOKA KROZ OTVORENU VIJAČU

### Sažetak

*Uvod: Ritmička gimnastika (RG) je sport sa visokim zahtjevima u skokovima. Skokovi spadaju u fundamentalne čovjekove kretnje, koje zahtijevaju složenu koordinaciju i gornjih i donjih segmenata tijela. Da sve bude zanimljivije i kompleksnije, skokovi u RG se gotovo uvijek izvode uz manipulaciju nekim od rekvizita (lopta, vijača, obruč, traka, čunjevi), a ta manipulacija podrazumijeva izbacivanje ili prolazak kroz rekvizit. I pored sve veće popularnosti ovog Olimpijskog sporta, osjeća se nedostatak biomehaničkih analiza u literaturi u pogledu tehničkih elemenata. Cilj: Cilj istraživanja bio utvrđivanje razlika u pojedinim kinematičkim parametrima dvije vrste dalekovisokih skokova, koje mogu imati utjecaj na zadržavanje dobro definiranog „split“ oblika. Metode: Istraživanjem je obuhvaćena jedna ispitanica - Evgeniya Olegovna Kanaeva, ruska ritmička gimnastičarka, aktualna svjetska prvakinja, jedina kojoj je u povijesti ritmičke gimnastike pošlo za rukom da osvoji šest zlatnih medalja na Svjetskom prvenstvu. Uzorak varijabli je podrazumijevao slijedeće kinematičke parametre kod obje vrste skoka: trajektorija težišta tijela po X i Y osi i resultantna brzina kretanja težišta tijela (TT). Podaci su dobiveni postupkom digitalizacije, pomoću softvera za kinematičku analizu Hu-m-an™, Version 5.0. Osnovni deskriptivni parametri i statistička značajnost razlika utvrđeni su pomoću SPSS 12.0, statističkog programa za obradu podataka. Rezultati: Analizom apsolutnih učestanosti resultantne brzine TT, uočava se normalnija distribucija apsolutnih vrijednosti brzine kod jednonožnog dalekovisokog skoka iz zaleta. T-test je pokazao da ne postoje statistički značajne razlike ( $p=.186$ ) aritmetičkih sredina vrijednosti brzine kretanja težišta tijela kod dalekovisokog skoka iz mjesta sunožnim odrazom i iz zaleta jednonožnim odrazom, ali je utvrđeno da postoji statistički značajna korelacija brzine u fazi leta jednog i drugog skoka ( $r=.658$ ,  $p=.002$ ). Zaključak: Skok sunožnim odrazom se zbog navedenih karakteristika može smatrati energetski zahtjevnijim i rizičnijim za povrede zbog prevelike brzine u trenutku doskoka i opravdano veće težine u odnosu na skok jednonožnim odrazom (0.1 bod više).*

**Ključne riječi:** ritmička gimnastika, kinematička analiza, skok kroz vijaču, usporedba

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## RELATION OF THE NUMBER OF ERYTHROCYTES WITH THE LEVEL OF IRON IN THE SERUM OF PATIENTS SUFFERING FROM SIDEROPENIC ANEMIA

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*Original scientific paper*

### **Abstract**

*A retrospective study encompassing the analysis of laboratory results and medical charts was implemented on 147 patients with sideropenic anemia. The goal was to identify sex and age structure of the patients, and the statistical dependence of the number of erythrocytes with the level of free and bound iron in the serum. Out of the overall number of patients, 78% were females, 41,5% of them in the age group of up to 35 years. The largest group in male patients was in the age group of 50 years and older, with 20% of the overall number. The research showed that the iron (Fe) in the serum was lowered in 100% of the patients diagnosed with sideropenic anemia, which is, along with the values of hematocrits and hemoglobin which were lowered in about 70% of the patients, the basic parameter for diagnosing sideropenic anemia. It is confirmed that the number of erythrocytes is insufficient as an indicator of certain hematological disorders. Namely, the number of erythrocytes was lowered in only 28% of the patients. The average values of the number of erythrocytes by age groups indicate neither lowered values, nor the statistical dependence on values of the serum iron, whether it is free or bound. Thus, the starting hypothesis set forth at the beginning of the study was confirmed.*

**Key words:** *sideropenic anemia, erythrocyte, serum iron*

### **Introduction**

Anemia is caused by decrease in number of erythrocytes or in quantity of hemoglobin. This could be caused by blood loss, deficient production of blood cells, their increased degradation, or by combination of everything aforementioned. Sideropenic anemia is caused by deficit of iron in the organism. It is a considerable health issue. Epidemiological data indicate that it is present in considerable percentage in both males and females. The main risk factor is lower intake or higher loss of the iron. It is most common in females of reproductive age due to considerable loss of blood during menstruation and due to heightened demands during pregnancy and nursing. For males and females who are not in reproductive age any longer, the most common cause of sideropenic anemia is inconspicuous bleeding of gastrointestinal tract. For these patients it is necessary to undertake examination of the entire digestive tube (for females, gynecological examination as well) in order to establish the cause of bleeding as soon as possible having in mind the possibility that the cause could be due to malignant disease. Sideropenic anemia is most common in vegetarians, which is understandable considering that the food of animal origin is richer in iron. Rarer causes of sideropenic anemia could be hemodialysis, Pulmonary Hemosiderosis, hypothyroidism and hyperthyroidism, and some intestinal parasites. Number of erythrocytes in peripheral blood is the result of balance between

dynamic processes involved in production of erythrocytes (erythropoiesis) and loss of erythrocytes from peripheral blood. In the process of maintaining the hematopoiesis on normal level, the iron plays important role as nutritive factor (as part of the HEM structure). For that reason, establishment of the iron level in serum (in its every metabolic form) is important factor in maintaining normal quantity of blood i.e. normal oxygen function of the blood. There is a question if the relation of number of erythrocytes and level of free iron in the serum could be blamed for genesis of sideropenic anemia.

#### **Primary hypotheses**

- Level of free iron found in serum considerably affects the change in number of erythrocytes found in peripheral blood in patients suffering sideropenic anemia

- Level of TIBC (total iron bounding capacity) considerably affects number of erythrocytes found in peripheral blood in patients suffering sideropenic anemia.

#### **Nil hypotheses**

- Level of free iron found in serum does not considerably affect the change in number of erythrocytes found in peripheral blood in patients suffering

- Level of TIBC (total iron bounding capacity) does not considerably affect number of erythrocytes found in peripheral blood in patients suffering sideropenic anemia.

The main goals of this study were:

- Establishing sex and age structure of patients suffering sideropenic anemia in Medical Centre Zavidovići
- Establishing level of free and bound iron in serum of aforementioned patients
- Establishing number of erythrocytes in relation to age and sex structure of the patients
- Establishing correlation of number of erythrocytes in peripheral blood and levels of :
  1. Free iron
  2. Total Iron Bounding Capacity (TIBC)

## Materials and methods

It was a random, retrospective study encompassing 147 patients in total. Patients were divided in following age groups: patients up to 25 years of age, 25-35, 35-50, and over 50 years of age. Their laboratory results were studied, as well as their patient records. Patients chosen for this study were those who contacted their doctors for the first time related to symptomatology of sideropenic anemia, as well as those patients suffering relapse of illness. To all of them sideropenic anemia was diagnosed based on anamnesis, clinical features and laboratory results.

## Results and discussion

Total of 147 patients were included in this study, all of whom were diagnosed with sideropenic anemia based on clinical features and lowered values of at least two of three set parameters: iron (Fe) in serum, hemoglobin (Hb) and hematocrit (Hct). Of the entire number of subjects (147), 78% are females, male patients make up for 22%. Higher occurrence of sideropenic anemia among female population was confirmed in the study done by Corraçcio A. and associates. It is interesting that data reached by this study concur with data from aforementioned study (Corraçcio A. and associates) related to age structure of the patients. Namely, over 40% of patients (41,5%) are females of up to 35 years of age. On the other hand, when considering the same age group for male patients they make up for just 3% of the entire number. From the entire number of male patients as much as 71% of them belong to age group of over 50. This particular group is often affected by illnesses of gastrointestinal tract (ulcers, tumors!) which is particularly important for diagnosis and treatment. Study confirmed that the number of erythrocytes is insufficient data when interpreting particular hematological disorders, especially sideropenic anemia. Namely, number of erythrocytes was lowered in 28% of subjects, normal in 63% of subjects, and heightened in 9% of subjects, and it cannot be taken as considerable factor when considering specific

disorder. Study confirms researches done by Frewin and associates up to day, in which it is established that heightened or normal number of erythrocytes is physiological response of the organism to their lowered functioning. Namely, it is the case of abnormal form of erythrocytes (microcytes) which have lower oxyforming capability. It was established that values of hemoglobin and hematocrit are much more significant. Interesting fact is that hematocrit was lowered in as many as 78% of cases, when compared to 28% of cases with lowered number of erythrocytes. This could be explained by the fact that sideropenic anemia belongs to microcytes anemia, which implies decrease of erythrocytes volume.

This exactly is the reason why even when value of erythrocytes numbers were not decreased, values of hematocrites were still low. Total Iron Bounding Capacity (TIBC) is a blood test which indicates the ability of transferrin to carry iron. It should be noted that results of iron concentration without TIBC are with no consequences and that these two test should always be done simultaneously. Values of TIBC are especially significant differential diagnostic parameter when considering anemia of chronic illnesses. In both types of anemia, concentration of iron is decreased, but in the case of sideropenic anemia UIBC is high, TIBC is normal or high, concentration of ferritin is lowered. In anemia of chronic illnesses UIBC and TIBC are decreased, and concentration of ferritin is normal. Study showed that values of TIBC in patients suffering sideropenic anemia are increased in all age groups regardless of sex. In male patients values of TIBC are highest in age group up to 25 and over 50 years of age. Age group of female patients ranging 25 -35 years of age demonstrates highest values of TIBC. These heightened values of TIBC are result of physiological defense and endeavor of organism to increase the level of free iron by activating its bound form. TIBC represents indirect measuring of transferrin, the part that still has the ability to bind the iron. Exact opposite is right for values of transferrin saturation. Transferrin, serum protein which carries out transport, releases the iron in endeavor to compensate for its deficit. Study established considerable decrease in value of transferrin saturation in all patients. Normal values of transferring saturation are expressed in percentages and range from 25 to 45%. Patients from the age group of over 50 regardless of sex, demonstrate lowest values of transferring saturation, around 7%. Interesting facts were revealed by comparison of number of erythrocytes with values of free and bound iron in the blood. Number of erythrocytes does not exhibit lowered values in considerable percentage, which is to be expected when considering anemia.

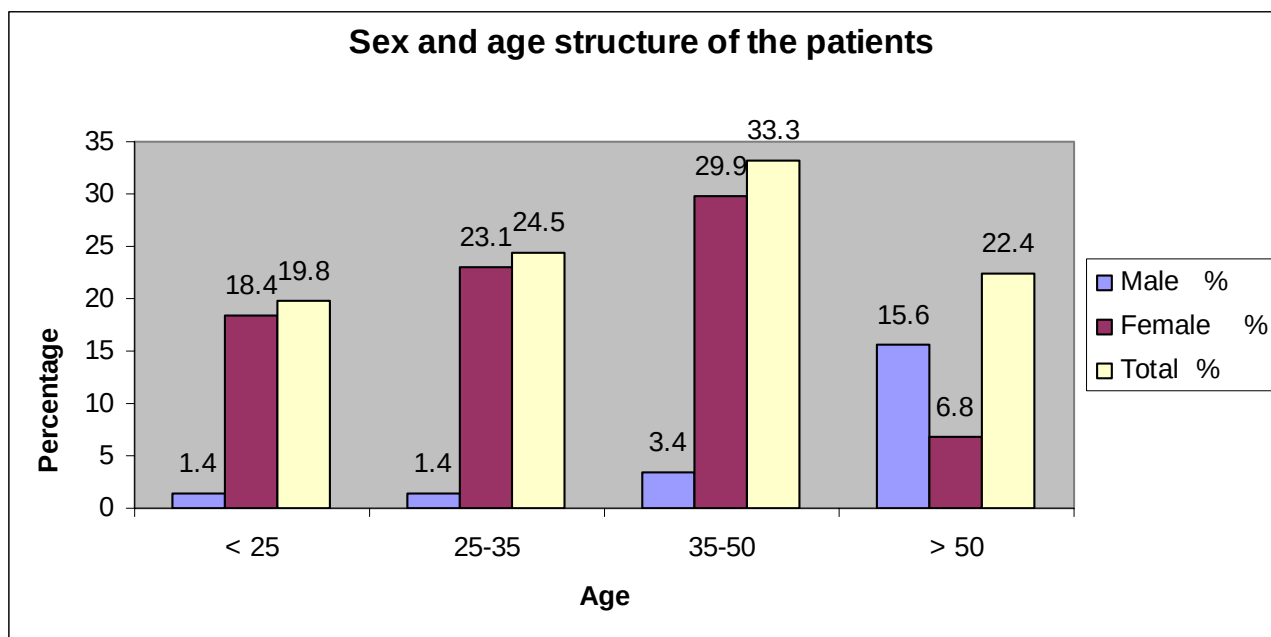


Figure 1. Sex and age structure of the patients

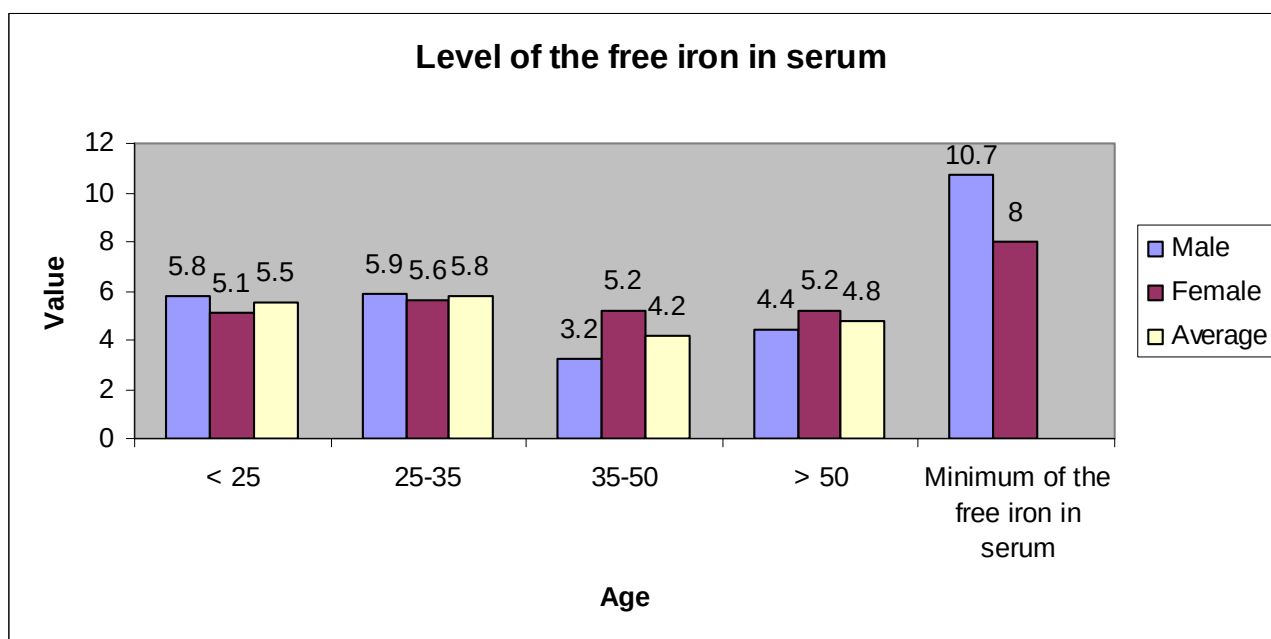


Figure 2. Level of the free iron in serum

(Physiological values of free iron in serum: Male: 10,7 – 28,6 µmol/L; Female: 8 – 26 µmol/L)

That is the sign that organism, even in situation of lowered values of iron in serum, still endeavors to improve oxyforming function of blood by producing erythrocytes. Nevertheless, thus produced erythrocytes are of lesser quality, with lowered volume and function. Erythrocytes of this kind are called microcytes. Considerable number of reticulocytes can be found in the blood as well, they are predecessors of genesis of mature erythrocytes. Obtained data confirm the nil hypotheses, i.e. hypothesis stating that

level of free and bound iron does not considerably affect the number of erythrocytes found in peripheral blood of patients suffering from sideropenic anemia. This finding reinforces the facts that when diagnosing anemia other factors are of more significance, especially hemoglobin and hematocrit. Considering the sideropenic anemia, apart from factors mentioned above, weighting factors are values of free Fe, TIBC, as well as transferrin and ferritin.

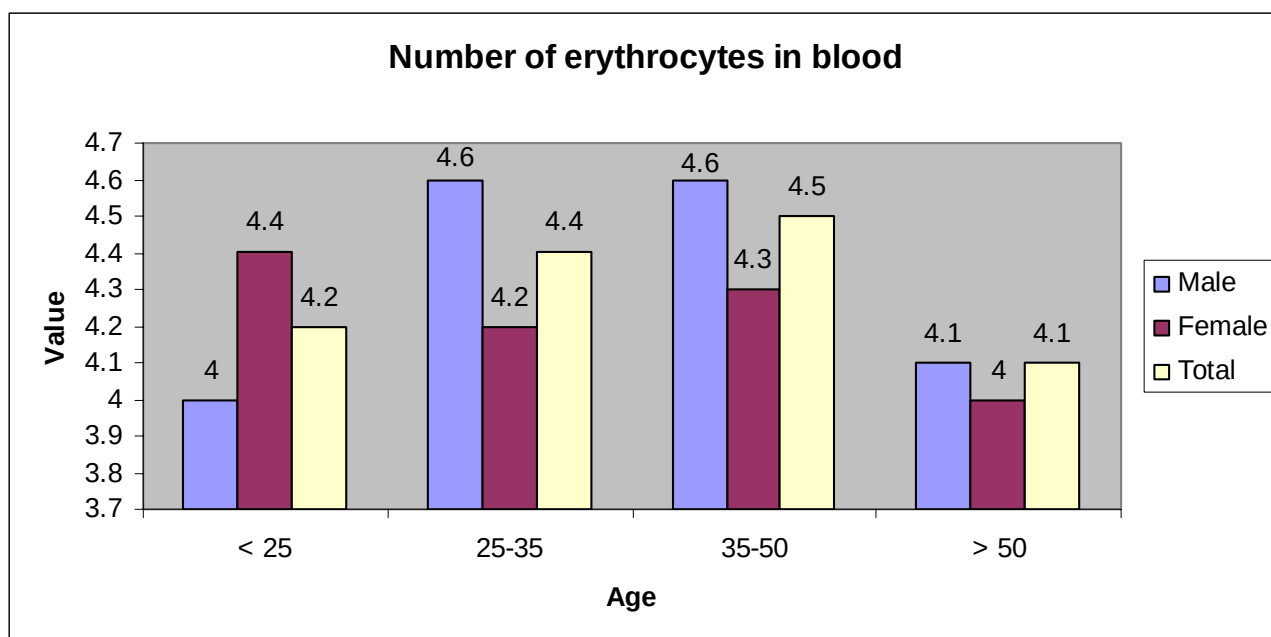


Figure 3. Number of erythrocytes in blood

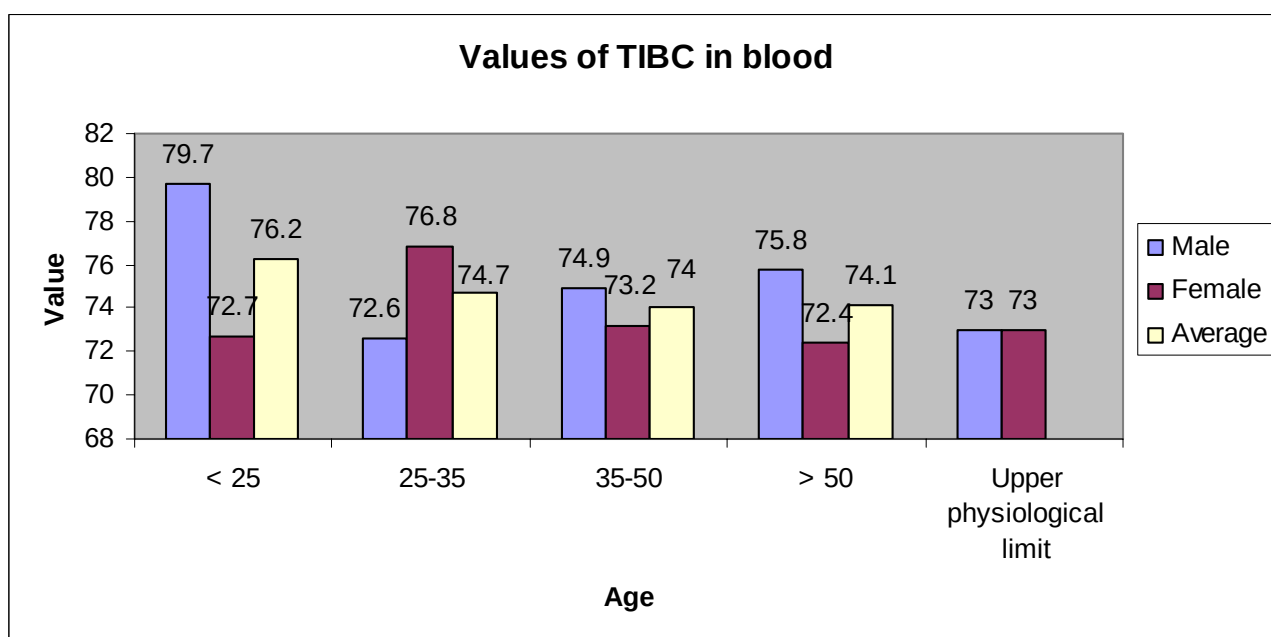
(Physiological values of number of erythrocytes in blood: Male:  $4-5 \times 10^{12}/L$ ; Female:  $4-5 \times 10^{12}/L$ )

Figure 4. values of TIBC in blood

(Physiological values of TIBC in blood: Male:  $45 - 73 \mu\text{mol}/L$ ; Female:  $45 - 73 \mu\text{mol}/L$ )

## Conclusions

Based on results of this study as well as studies of other authors (results of which are available) we can make the following conclusions:

- In subject group of 147 patients, 115 were female patients, i.e. 78%;
- The largest percentage of female patients suffering from sideropenic anemia belongs to age group of up to 35 years of age, as much as 41,5% of the entire number;
- The largest percentage of male patients suffering from sideropenic anemia belongs to age group of over 50 years of age, approximately 20% of the entire number;

- Fe in serum is decreased in 100% of subjects diagnosed with sideropenic anemia;
- Values of transferring saturation are decreased in 100% of subjects diagnosed with sideropenic anemia;
- TIBC is decreased in 53% of examined patients;
- Level of free Fe in plasma of patients suffering sideropenic anemia has no significant effect on number of erythrocytes in peripheral blood;
- Level of bound Fe in plasma of patients ne has no significant effect on number of erythrocytes in peripheral blood.

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## RELACIJA BROJA ERITROCITA SA NIVOOM SLOBODNOG ŽELJEZA U SERUMU KOD PACIJENATA SA SIDEROPENIČNOM ANEMIJOM

### Sažetak

Vršena je retrospektivna studija koja obuhvata analizu laboratorijskih nalaza i zdravstvenih kartona ukupno 147 pacijenata oboljelih od sideropenične anemije. Cilj je bio utvrditi polnu i starosnu strukturu pacijenata, te statističku ovisnost broja eritrocita sa nivoom slobodnog i vezanog željeza u serumu. Od ukupnog broja ispitanika, 78% su bile osobe ženskog pola, od njih čak 41,5% u grupi pacijenata do 35 godina. Kod muškog pola, najveću grupu čine pacijenti starije životne dobi, preko 50 godina, sa oko 20% ukupnog broja. Istraživanje je pokazalo da je željezo (Fe) u serumu bilo sniženo kod 100% ispitanika sa dijagnosticiranom sideropeničnom anemijom, te su to, uz vrijednosti hematokrita i hemoglobina koje su bile snižene u prosjeku kod 70% pacijenata, osnovni parametri za postavljanje dijagnoze sideropenične anemije. Potvrđeno je da je broj eritrocita nedovoljan podatak za interpretaciju pojedinih hematoloških poremećaja. Naime, broj eritrocita je bio snižen samo kod 28% ispitanika. Prosječne vrijednosti broja eritrocita po starosnim grupama ne pokazuju snižene vrijednosti, niti statističku ovisnost o vrijednostima serumskog željeza, bilo vezanog bilo slobodnog. Na taj način je potvrđena nulta hipoteza postavljena na početku istraživanja.

**Ključne riječi:** sideropenična anemija, eritrociti, serumsko željezo

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## TRANSFORMATION OF BASIC AND SPECIFIC MOTOR STATUS OF ELITE JUDO PLAYERS UNDER THE INFLUENCE OF INNOVATED TRAINING MODEL

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*Original scientific paper*

### **Abstract**

*According to the rules of long term planning and program the relation of certain sport preparation programs is changing in some phases. In the first phase the biggest contribution make general and basic preparations. In the phase when judo player is approaching maximum sport results specific-situational preparation is taking part. Hours of training are increasing and reach values which prove that judo players should spend approximately four hours and longer training in order to achieve top results. Considering this extension we can conclude that increasing the total amount of training in later phases of sports improvement is realized based on increasing of specific-situational training and number of competitions. Certainly, all this has to be followed by discipline in a life of a sportsman. Modern sports preparation technology faces bigger challenges through years. Judo development, changes in fighting rules, requirements and expectations of public result with constant modifications and innovations in sport preparation program creation. Trainers and scientist make an effort to discover new methods, training programs that will shorten the road to achievement of the top sport results.*

**Key words:** judo, elite players, training, innovative model, technique, motor dimensions

### **Introduction**

Judo characterizes variety and a lot of technical elements, tactics of whole body and extremity movement in different directions with variable intensity and tempo. During judo fight dynamic situations are constantly changing along with different moves changes, intervention and position of both fighters. This requires good dynamic stereotype activities and throw and good ability to effectively carry out the reorganization of the dynamic stereotype in other words continually creating new offensive, defensive and counter defense activities during the fight (Rađo & Co, 2001). Technical preparation of judo players is a process of motor habits formation; throwing, holding procedures, Arm Bars, chokes, defense, and their combinations that are used in combat sports. During training the beginners, judo players learn specific elements of technique, while in the further course of training technique's perfected to a point when it can be used in combat sports. During this period of education basic technique significantly increases. Along with this motor skills are developing in terms of specific training of coordination skills performance. Specific physical training influences the development of motor characteristics necessary to perform specific movements in judo. When choosing the appropriate specific exercises for judo and direct them towards training of any motor characteristics, it is necessary to previously study the structure of certain judo methods and activities of individual groups of muscles involved in performing techniques. According to this, we realize which muscles are mostly involved during performing of particular technique, which gives us a starting point for the selection of a certain specific exercises complex that will have the most effective impact.

In addition to the development of certain muscle groups, specific means of preparation will influence the development of motor characteristics, which we discover that, at the moment, cause the development of certain qualities specific for judo. The aim of the research would be to determine the effects of different methods on general and specific motor of judo players.

### **Methods**

#### *Sample of respondents*

The sample comprised 179 male judo players aged 17 to 27 years who have at least master title in judo and day as follows: Experimental group – 61 respondent and Control group – 118 respondents from Croatia, SCG and Slovenia.

#### *Sample of variables*

For assessment of fundamental motor skills in judo players (dynamic strength, explosive strength, coordination and speed) 12 tests were applied. For coordination: (1) Climbing and alighting on the bench and Swedish ladders (MBKPIS); (2) Side steps (MAGKUS); (3) figure eight with bending (MAGOSS). Following tests were applied to assess repetitive strength: (4) Pull ups on high bars in backward grip (MRAZGP); (5) Sit-ups in 30 sec (MBDT30); (6) side movements of a torso in a lying position (MRSZTL). Following tests were applied to assess explosive strength: (7) throwing medicine ball from lying on one's back (MFEBML); (8) Standing long jump (MFESDM); (9) Sargent test (MFESVM). Following tests were applied to assess movement frequency: (10) Hand tapping (MBFTAP); (11) Circulating with hand (MBFKRR); (12) Foot tapping (MBFTAN).

For specific motor skills estimation in judo we applied battery of tests designed by Janos Kopas (2005). For specific repetitive strength estimation: (13) Jumping over and pulling through (SPPR10); (14) Uchi komi – Tai otoshi (SUKT10); (15) Jumping on supporting leg (SPSNO8). For specific coordination movement estimation: (16) Ko uchi makikomi (SKUMK5); (17) Ground floor circle (SPAKRU); (18) Uchimata with somersault forward (SUMKO5). For specific explosive strength estimation: (19) Single leg jumping five times (SPESJN); (20) Agility on the ground (SOKRNT). For specific speed (frequency) of movement: (21) Ipon seoi nage (SISN10); (22) Fall forward over the opponent (SPAN10). In addition to these tests, we decided to apply following tests since in earlier study we did not obtaine satisfactory psychometric properties and for these reasons tests are performed with correction of test tasks: (23) Movement on the back feet forward (SKLN10); (24) Bridging (SMOST5); (25) Sumi-gaeshi to kesa-gatame (SSGKG); (26) Knee throw (SBAKO5); (27) Moving on the stomach with hand withdrawal (SKSPR5); (28) Movement on the back with head forward (SLGN10).

#### Experimental design

Experiment was realized within three months. In the beginning of technical training, in introductory section, we performed a battery of specific mobility exercises that stimulate movements that occur in the execution of some judo techniques (15 to 20 minutes long exercises).

Specific motor exercise complex (30 exercises) was created by PhD Izet Rađo and author of PhD thesis Branislav Crnogorac, based on many years of training and a great professional experience. During the physical training plyometric training was applied contained of 15 plyometric exercises, which were considered to have a positive transfer on the development of motor skills dominant in judo.

Also, after judo training we applied training on a specially designed training devices (horizontal bars "rukohod", high bars with kimono attached and the rope from kimono lapel) which were considered to improve specific motor skills specific for judo. Experimental group implemented this program for three months and control group followed standard curriculum that is implemented in the clubs.

#### Statistic procedures

Multivariate analysis of covariance tested differences between the experimental and control group at the final measurement with the neutralizing effect of possible differences in the level of general and specific motor abilities of subjects in the two groups at the beginning of treatment. Within this analysis we calculated Wilk's  $\lambda$  coefficients and their value tested with appropriate F test which verified the significance of differences at the level of the whole system of the analyzed variables. Significant values were the values of F test that fulfilled the level of significance  $p=0,01$ .

## Results and discussion

Table 1: Differences between groups in space of Basic motor dimensions

| Variables              | Group | Mean     | F test | Significance |
|------------------------|-------|----------|--------|--------------|
| MBKPIS                 | Exp.  | 202,28   | 4,44   | ,04          |
|                        | Cont. | 209,05   |        |              |
| MAGKUS                 | Exp.  | 89,15    | 117,42 | ,00          |
|                        | Cont. | 94,98    |        |              |
| MAGOSS                 | Exp.  | 171,78   | 44,45  | ,00          |
|                        | Cont. | 175,77   |        |              |
| MRAZGV                 | Exp.  | 13,65    | 165,63 | ,00          |
|                        | Cont. | 10,55    |        |              |
| MBDT30                 | Exp.  | 32,22    | 59,25  | ,00          |
|                        | Cont. | 30,04    |        |              |
| MRSZTL                 | Exp.  | 61,22    | 134,91 | ,00          |
|                        | Cont. | 52,84    |        |              |
| MFEBML                 | Exp.  | 1.064,15 | 130,56 | ,00          |
|                        | Cont. | 985,45   |        |              |
| MFESDM                 | Exp.  | 243,63   | 110,10 | ,00          |
|                        | Cont. | 233,51   |        |              |
| MFESVM                 | Exp.  | 48,78    | 4,58   | ,03          |
|                        | Cont. | 47,78    |        |              |
| MBFTAP                 | Exp.  | 39,38    | 17,33  | ,00          |
|                        | Cont. | 38,20    |        |              |
| MBFKRR                 | Exp.  | 39,27    | ,21    | ,65          |
|                        | Cont. | 38,07    |        |              |
| MBFTAN                 | Exp.  | 22,72    | 2,67   | ,10          |
|                        | Cont. | 21,99    |        |              |
| Wilks $\lambda = 0,81$ |       | F = 3,20 | df1=12 | df2=166      |
|                        |       |          |        | p = 0,00     |

Table 2: Differences between groups in space of Specific motor dimensions

| Variable               | Group | Mean     | F-test  | p        |
|------------------------|-------|----------|---------|----------|
| SKLN10                 | Exp.  | 106,51   | 142,314 | ,00      |
|                        | Cont. | 119,65   |         |          |
| SPPR10                 | Exp.  | 268,81   | 109,162 | ,00      |
|                        | Cont. | 285,90   |         |          |
| SOKRNT                 | Exp.  | 40,44    | 100,936 | ,00      |
|                        | Cont. | 43,39    |         |          |
| SMOST5                 | Exp.  | 79,68    | 99,559  | ,00      |
|                        | Cont. | 87,44    |         |          |
| SPAN10                 | Exp.  | 181,59   | 21,032  | ,00      |
|                        | Cont. | 190,90   |         |          |
| SSGKG5                 | Exp.  | 135,22   | 95,602  | ,00      |
|                        | Cont. | 140,01   |         |          |
| SPAKRU                 | Exp.  | 42,56    | 101,073 | ,00      |
|                        | Cont. | 45,16    |         |          |
| SBAKO5                 | Exp.  | 60,96    | 54,488  | ,00      |
|                        | Cont. | 63,55    |         |          |
| SKSPR5                 | Exp.  | 68,39    | 109,614 | ,00      |
|                        | Cont. | 76,67    |         |          |
| SLGN10                 | Exp.  | 70,70    | 47,533  | ,00      |
|                        | Cont. | 76,63    |         |          |
| SPSNO8                 | Exp.  | 29,14    | 218,212 | ,00      |
|                        | Cont. | 33,91    |         |          |
| SPESJN                 | Ekep. | 1.162,08 | 252,832 | ,00      |
|                        | Kont. | 1.101,48 |         |          |
| SKUMK5                 | Exp.  | 85,16    | 31,097  | ,00      |
|                        | Cont. | 88,89    |         |          |
| SISN10                 | Exp.  | 96,64    | 93,705  | ,00      |
|                        | Kont. | 101,73   |         |          |
| SUKT10                 | Ekep. | 159,34   | 36,407  | ,00      |
|                        | Cont. | 170,17   |         |          |
| SUMKO5                 | Exp.  | 104,55   | ,203    | ,65      |
|                        | Cont. | 105,10   |         |          |
| Wilks $\lambda = 0,63$ |       | F = 6,02 | df1=16  | df2=162  |
|                        |       |          |         | p = 0,00 |

In table 1 we presented results of multivariate analysis of covariance, which were tested for differences in the general area of motor between two groups the experimental and control co variations of results from the first measurement, or by neutralizing the existing differences in the initial measurement. It is obvious that on the level of entire variable analysis system it showed there is statistically significant difference between analyzed groups at the level of conclusion  $p = 0,01$  as indicated by high values of Wilks  $\lambda$  coefficient (0.81) and F test (3.20). Out of 12 analyzed variables only two did not present statistically significant differences (MBFKRR and MBFTAN), while the variables and MBKPIS MFESVM noted differences at the level of the conclusion of  $p = 0.05$ . In all cases these differences are still in favor of the experimental group. Multivariate analysis of covariance, which tested the differences in the area of specific motor skills between the experimental and control groups at the final measurement (Table 2), revealed that there are significant differences between groups analyzed at the level of the conclusion of  $p = 0.01$ , as indicated by high value of F test (6.02) and Wilks  $\lambda$  coefficient (0.63).

In all 16 analyzed variables, except variable SUMKO5, statistically significant differences are present at the level of the conclusion of  $p = 0$ . In all cases these differences are still in favor of the experimental group.

It is important to confirm that the use of innovated model of training did not only affect the specific motor status of judo players but also the general motor status. Basic motor skills include capabilities unspecific for certain sport activity but have impact on specialization process while transforming into specific capabilities, but only if they are in certain correlations (Malacko & Rađo, 2004).

In other words treated specific motor skills through transformation process can affect motor skills under the same conditions. High efficiency and effectiveness in achieving sports results cannot be achieved on the behalf of extensiveness (amount and time) but with increasing intensity (power and optimization) of training, which requires future faster selectivity in appliance of the most efficient training instruments, methods and (Malacko & Rađo, 2004).

According to difference analysis in final measuring between experimental and control group we can conclude that appliance of innovative model in judo practitioners training showed better results regarding positive transformation of basic and specific motor skills of players comparing to standard model appliance. Specific motor exercises should be included in training since the beginning because of positive impact on better motor studying in later judo player's preparations which was confirmed in earlier research. (Drid, 2005; Bratić et al., 2006). This research confirmed this statement. New specific motor skills should be studied in three phases: 1) learn exercise regardless performance speed, 2) increase performance speed while keeping correct movement structure and 3) change a part of movement structure or conditions it's being performed by.

Training instruments should be included into training process only when active and passive part of movement apparatus becomes strong enough. This can be achieved with development of general strength, speed, coordination, flexibility and other motor skills. One of the basic principles of sports training in judo is the principle of individualization. Individualization is imposing itself as one of the major requirements of modern training.

This refers to the fact that trainers should approach each judo player individually according to his skills, potential, learning characteristics and sport specificity regardless sport results level (Bompa, 1999). Individualization should be observed as an instrument that can be easily assessed and followed by judo player. All types of individual judo player's training are based on information obtained from precise diagnostic procedures.

State diagnosis is being conducted in order to define the level of judo player's anthropological dimensions. Health conditions, motor and functional skills, morphological characteristics and psychosociological dimensions are being estimated with general and specific procedures and tests (Milanović, 1997; Beachle i Earle, 2000; Cook, 2000). Information obtained is considered in creation of training curriculum. For that reason it is essential to create as much specific motor skills assessment tests for judo players as possible.

## Conclusion

According to the rules of long term planning and program the relation of certain sport preparation programs is changing in some phases. In the first phase the biggest contribution make general and basic preparations. In the phase when judo player is approaching maximum sport results specific-situational preparation is taking part. Hours of training are increasing and reach values which prove that judo players should spend approximately four hours and longer training in order to achieve top results. Considering this extension we can conclude that increasing the total amount of training in later phases of sports improvement is realized based on increasing of specific-situational training and number of competitions. Certainly, all this has to be followed by discipline in a life of a sportsman. Modern sports preparation technology faces bigger challenges through years. Judo development, changes in fighting rules, requirements and expectations of public result with constant modifications and innovations in sport preparation program creation. Trainers and scientist make an effort to discover new methods, training programs that will shorten the road to achievement of the top sport results.

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## TRANSFORMACIJA BAZIČNOG I SPECIFIČNOG MOTORIČKOG STATUSA VRHUNSKIH DŽUDISTA POD UTICAJEM INOVIRANOG MODELA TRENIRANJA

### Sažetak

*U skladu sa zakonitostima dugoročnog planiranja i programiranja mijenja se odnos pojedinih programa sportske pripreme u pojedinim etapama. U prvim etapama najveći je udio programa opće i bazične pripreme. U funkciji približavanja etapi u kojoj džudist postiže maksimalna sportska dostignuća povećava se udio programa specifično-situacijske pripreme. Broj sati trenažnog rada stalno se povećava i postiže vrijednosti koje znače da džudist radi postizanja vrhunskih sportskih rezultata mora prosječno dnevno trenirati i više od četiri sata. Imajući na umu ovo povećanje, možemo zaključiti da se povećavanje ukupne količine trenažnog rada u kasnijim etapama sportskog usavršavanja ostvaruje na temelju znatnijeg prirasta specifično-situacijskih sadržaja trenažnog rada i broja takmičenja. Naravno sve ovo mora pratiti i sportski režim života sportiste. Tehnologija savremene sportske pripreme iz godine u godinu nailazi na sve veće izazove. Razvoj džuda, promjene u pravilima borbe, zahtjevi i očekivanja sportske javnosti, uvjetuju stalne modifikacije i inovacije u kreiranju programa sportske pripreme. Treneri i naučnici ulažu velike napore radi iznalaženja novih metoda, trenažnih programa koji će džudistima skratiti put do ostvarenja najvećih sportskih dostignuća.*

**Ključne riječi:** judo, elitni sportaši, trening, inovativni model, tehnika, motoričke dimenzije

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## EFFECTS OF INTENSIVE STRENGTH TRAINING ON CARDIOVASCULAR ENDURANCE

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Review paper

### Abstract

*Summary research on the topic: "Effects of intensive strength training on cardiovascular endurance", is selected to review the companion problems as the first in the world after death is not making a difference in age. We wish to contribute to clearing up the answer to the question of how intensive training of strength affecting changes the function of the cardiovascular system. Argues that we need knowledge and statistical data to what extent intensive strength contributes to transformation independently and in combination with some other type of training. It primarily thinks of the impact aerobic research out combined with strength training. Research interests include respondents of different age, different health problems, divided by sex. Various training programs can give us reliable data in a positive evaluation of training programs just applied to different categories of the population with all the differences (age, gender, health).*

**Key words:** training, strength, hearth, pressure and endurance

### Introduction

*Summary research on the topic: "Effects of intensive strength training on cardiovascular endurance", is selected to review the companion problems as the first in the world after death is not making a difference in age. We wish to contribute to clearing up the answer to the question of how intensive training of strength affecting changes the function of the cardiovascular system. Argues that we need knowledge and statistical data to what extent intensive strength contributes to transformation independently and in combination with some other type of training. It primarily thinks of the impact aerobic research out combined with strength training. Research interests include respondents of different age, different health problems, divided by sex. Various training programs can give us reliable data in a positive evaluation of training programs just applied to different categories of the population with all the differences (age, gender, health).*

### Previous research

Rimmer, Riley, Creviston & Nicola (2000) research exercise training in a predominantly african-american group of stroke survivors. The results indicated that the exercise group improved significantly in peak [Vo.sub.2], time to exhaustion, muscular strength in the bench press and leg press exercises, hamstring flexibility, and skinfold measurement. These variables either remained unchanged or worsened in the lag control group during the first 12-week iteration. No significant differences were observed between the two groups in shoulder flexibility, handgrip strength, or waist-to-hip ratios. The authors concluded that people with stroke can make significant fitness improvements with a supervised exercise program. They also suggested that greater efforts should be made to involve people with stroke in fitness and

physical activity programs and such programs may help reduce morbidity and disability in these people. Ferketich, Kirby & Alway (2002) research cardiovascular and muscular adaptations to combined endurance and strength training in elderly women. Chi-square analysis of fibre area data showed an increase in the frequency of larger type I fibres in the post-training data from the E & S group, but an increase in the frequency of smaller fibres in the E group post-training; however, mean fibre area was not significantly changed by training. These data suggest that greater improvements in sub-maximal time to fatigue and strength are achieved when resistance training is added to an aerobic training programme in healthy elderly women. Carvalho, Mota & Soares (2003) research strength training vs. aerobic training: cardiovascular tolerance in elderly adults. The aim of the present study was to evaluate cardiovascular tolerance to two different types of exercise (strength training vs. aerobic training) in healthy elderly subjects. The results showed no significant differences in heart rate (HR), sessions and by measuring systolic (SBP) and diastolic blood pressure (DBP) values between the two training types. Both sessions were performed at appropriate intensity without exaggerated cardiovascular response. In strength training, exercises that involved the legs presented higher rises in SBP and DBP values than those performed with the arms. These data suggest that, if appropriate techniques are used, strength training as well as gymnastics can be performed by healthy older subjects so long as basic rules for exercise in this population are followed. Furthermore, the data indicate a greater cardiovascular hemodynamic response after strength exercises with the legs than arms. Fröhlich, Schmidbleicher & Emrich (2004) research metabolic and cardiovascular response in strength endurance training.

The purpose of this empirical study was: 1<sup>st</sup>: To evaluate the strain in three specifically trained training groups (untrained, athletics and wrestler) by a constant stress (20-RM) in a typically strength endurance training. 2<sup>nd</sup>: To predict the strain in strength endurance training over six sets. The results are: The research load as an objective parameter decreased over the six sets and there was a significant difference between the three different groups. Lactic acid concentration increased in the same way over the sets and there was no statistic difference between the groups. The findings of heart rate, systolic blood pressure, double product and rating of perceived exertion remain clear. There was no health risk by usage rate in the set in the three groups. Wilborn, Greenwood, Wyatt, Bowden, & Grose (2004) research the effects of exercise intensity and body position on cardiovascular variables during resistance exercise. There were no significant ( $p > 0.05$ ) differences in systolic blood pressure (SBP) or heart rate (HR) between body position or apparatus. A significantly higher HR and BP were found in the following conditions for hack squat (HS): 65% > 1 RM, 85% > 1 RM, 65% > 85%. Also, during the leg press (LP) condition, BP and HR were greater at 65% than during 1 RM. These findings suggest cardiovascular measures are influenced by intensity, rather than apparatus or body position, during resistance exercise. Izquierdo, Häkkinen, Ibáñez, Kraemer & Gorostiaga (2005) research effects of combined resistance and cardiovascular training on strength, power, muscle cross-sectional area, and endurance markers in middle-aged men. No significant differences were observed in the magnitude of the increases in research load ( $W_{max}$ ) between endurance training alone (cycling exercise) (E) (14%), endurance (once weekly) training on muscle mass (SE) (12%) and E (10%) during the 16-week training period. During the last 8 weeks of training, the increases in  $W_{max}$  in E and SE were greater ( $P < 0.05$ – $0.01$ ) than that observed in resistance training alone (S). No significant differences between the groups were observed in the training-induced changes in sub-maximal blood lactate accumulation. Significant decreases ( $P < 0.05$ – $0.01$ ) in average heart rate were observed after 16 weeks of training in 150 W and 180 W in SE and E, whereas no changes were recorded in S. The data indicate that low-frequency combined training of the leg extensors in previously untrained middle-aged men results in a lower maximal leg strength development only after prolonged training, but does not necessarily affect the development of leg muscle power and cardiovascular fitness recorded in the cycling test when compared with either mode of training alone. Faulkner, Quinn, Rimmer & Rich (2005) research a cardiovascular endurance and heart rate variability in adolescents with type 1 or type 2 diabetes. This investigation explored the influence of type of diabetes, gender, body mass index (BMI) and metabolic control (HbA1c). Furthermore, exercise beliefs, physical activity on cardiovascular endurance (CE), and heart rate variability (HRV), too.

Regardless of the type of diabetes, females and those with higher BMI, poorer metabolic control, and lower amounts of physical activity tended to have lower levels of CE. Exercise beliefs consistently predicted both frequency and time domain HRV measures. Measures of exercise beliefs, self-reported physical activity, CE ( $V_0$  (2peak)), and HRV were significantly lower in adolescents with type 2 DM (diabetes measures) in comparison to those with type 1 DM. Early findings of poor physical fitness, lower HRV, fewer positive beliefs about exercise, and less active lifestyles highlight the importance of developing culturally sensitive interventions for assisting youth to make lifelong changes in their physical activity routines. Females, those with poorer metabolic control, and minority youth with type 2 DM may be particularly vulnerable to later cardiovascular disease. Okamoto, Masuhara & Ikuta (2006) research cardiovascular responses induced during high-intensity eccentric and concentric isokinetic muscle contraction in healthy young adults.

The purpose of this study was to determine the differences in cardiovascular response between high-intensity eccentric (ECC) and concentric (CON) contractions, and to obtain the basic data applicable to resistance training in middle-aged and elderly individuals. ECC were significantly smaller compared with CON. It is clear that cardiovascular response by high-intensity contraction is smaller in ECC than in CON. High-intensity ECC has been suggested to exert only small stress to the cardiovascular system. Thus, being a contraction mode it may be applicable to resistance training. D'Assunção et al. (2007) research acute cardiovascular responses in strength training conducted in exercises for large and small muscular groups. The aim of this study was to compare the behaviour of the systolic blood pressure (SBP); diastolic blood pressure (DBP); heart rate (HR) and double product (DP) during the unilateral performance of three sets of 10RM in two exercises involving distinct muscular groups. The two-way ANOVA with repeated measurements, followed by the post-hoc test by Tukey did not find differences ( $p > 0.05$ ) for intraexercises SBP. Therefore, at least in the present study, the muscular mass involved in the strength training did not influence the acute cardiovascular responses in trained normotensive subjects. Acute cardiovascular responses in strength training conducted in exercises for large and small muscular groups. Casey, Beck & Braith (2007) research progressive resistance training without volume increases does not alter arterial stiffness and aortic wave reflection. Results: there are no changes were observed in brachial flow-mediated dilation (FMD), plasma levels of nitrate/nitrite ( $NO_x$ ), norepinephrine (NE), or blood pressures. These results suggest that a resistance training (RT) protocol consisting of progressively higher intensity without concurrent increases in training volume does not increase central or peripheral arterial stiffness or alter aortic pressure wave characteristics in young subjects.

Bottaro et al. (2007) demonstrated that a high-velocity power resistance training program can be performed safely in older men and appears to be more effective in improving muscular power, and more importantly, functional performance, compared with a low-velocity traditional resistance training program. Compared to baseline, heart rate (HR) and double product (DP) were significantly ( $p < 0.05$ ) higher after the third set of both upper and lower body exercise in of all the protocols. HR and DP were significantly ( $p < 0.05$ ) lower in the two discontinuous rep protocols compared with the continuous rep protocol for upper body exercise.

However, HR and DP were significantly ( $p < 0.05$ ) lower only in the discontinuous (5 second rest) protocol for lower body exercise. It appears that discontinuous high-velocity resistance exercise, otherwise known as power training, may have a lower cardiovascular demand than continuous resistance exercise in older women. These findings may help exercise scientists to prescribe high velocity resistance exercise in a safety manner. Also, help encourage long term adherence to power training in the elderly population. Da Silva et al. (2007) research high-velocity resistance exercise protocols in older women: effects on cardiovascular response. Acute cardiovascular responses to different high-velocity resistance exercise protocols were compared in untrained older women. Compared to baseline, heart rate (HR) and rate pressure product (RPP) were significantly ( $p < 0.05$ ) higher after the third set in all protocols. HR and RPP were significantly ( $p < 0.05$ ) lower in a pause of five (DP5) and 15 (DP15) compared with continuous protocol (CP) for the bench press (BP) exercise. Compared to baseline, Rating of Perceived Exertion (RPE) increased significantly ( $p < 0.05$ ) with each subsequent set in all protocols.

Blood lactate concentration during DP5 and DP15 was significantly lower than CP. It appears that discontinuous high-velocity resistance exercise has a lower cardiovascular demand than continuous resistance exercise in older women. Resnik et al. (2007) research the resistance training as important component of cardiac rehabilitation; however, there are concerns about orthopaedic and hemodynamic complications. The purpose of our study was to evaluate the effects of resistance training on muscle strength and hemodynamic response in patients with coronary heart disease (CHD). All patients completed the weightlifting exercises without dysnea and/or chest pain, increasing their muscle strength in P 34.34%, D 15.51%, B 16.75% and C 18.72%. These values were statistically significance ( $P < .05$ ), in comparison to hemodynamic variables: heart rate, systolic and diastolic blood pressure (NS). Resistance training has demonstrated to be safe, using appropriated research loads, improving upper and lower body strength with an adequate cardiovascular response. Vincent et al. (2007) research strength training and hemodynamic responses to exercise. Post-training, time to peak systolic and diastolic blood pressures and heart rate

was increased in the low-intensity exercise (LEX) and high-intensity exercise (HEX) groups by 22.9% and 44.5%, respectively ( $p < 0.05$ ). Diastolic blood pressure, heart rate, and mean arterial pressure during the graded exercise test (GXT) were significantly decreased ( $p < 0.05$ ) in the high-intensity exercise group HEX group following training. Post-GXT heart rate was lower in the HEX and LEX groups compared to control ( $p < 0.05$ ) indicating a more rapid recovery. Resistance exercise prolongs the onset of peak cardiovascular responses, decreases the cardiovascular response to exertion, and improves recovery from maximal exertion. Polito et al. (2008) research discontinuous sets of knee extensions induce higher cardiovascular responses in comparison to continuous ones. To compare the acute cardiovascular responses of systolic arterial pressure (SAP), diastolic arterial pressure (DAP), heart rate (HR) and double product (DP) during the unilateral knee extension (four series of 8 maximum repetitions) performed continuously or discontinuously. The discontinuous series showed significantly higher values when compared to the protocol of the continuous series. The discontinuous protocol promoted higher increase in pressure responses when compared to the continuous one. The strength training can promote significant cardiovascular responses during its performance and it is interesting to devise strategies to reduce them, without compromising the strength production.

## Participants

Research on the topic: "Effects of intense strength training on cardiovascular endurance", were selected in four ways, namely: by age (5 categories), research on gender of respondents (men, women, both sexes), based on health status (ill and healthy), based on the training program (strength and aerobic) and it all finally summarized in obtaining the sum of positive or negative results.

Table 1. Basic information

| Year     | 25-35 | 35-45 | 45-55 | 55-65 | 65-75> | $\Sigma$ |
|----------|-------|-------|-------|-------|--------|----------|
| M        | 3     | /     | /     | /     | 1      | 4        |
| W        | /     | 1     | 1     | 1     | 3      | 6        |
| B        | 1     | 1     | /     | 1     | 2      | 5        |
| $\Sigma$ | 4     | 2     | 1     | 2     | 6      | 15       |
| Se       | /     | /     | /     | 2     | 1      | 3        |
| H        | 4     | 2     | 1     | /     | 5      | 12       |
| $\Sigma$ | 4     | 2     | 1     | 2     | 6      | 15       |
| St       | 4     | 1     | 1     | /     | 4      | 10       |
| St+At    | /     | 1     | /     | 2     | 2      | 5        |
| $\Sigma$ | 4     | 2     | 1     | 2     | 6      | 15       |
| +        | 2     | 1     | /     | 2     | 6      | 11       |
| -        | 2     | 1     | 1     | /     | /      | 4        |
| $\Sigma$ | 4     | 2     | 1     | 2     | 6      | 15       |

Legend: M-men, W-women, B-both (M&W), Se-Seek (ill), H-health, St-strength training, At-aerobic training.

## Discussion and conclusion

Total researches subjects include age from 25 to 35 years were 4 (3 men and 1 of both sexes). All four studies were conducted of subjects who were healthy. Strength training program is the only program in the experimental treatment in all studies in this category. Positive research results showed that the two researches are positive and other two researches are negative. Total research subjects include age from 35 to 45 years was 2 (1 with women and 1 of both sexes). The survey was conducted of the respondents who were healthy. Strength training program was in one experimental treatment, and the program of aerobic training with strength in the second experimental treatment.

Positive result shows one research, and a negative result also shows one research. Total research subjects include age from 45 to 55 years was 1 with women. Both studies were conducted of subjects who were healthy. The program was in force only in the experimental treatment. The experimental program is given a negative result. Total research subjects include age from 55 to 65 years was 2 (1 with women and 1 of both sexes).

The survey was conducted of the respondents who were healthy. The strength program with aerobic training was present in both experimental treatments. Positive results show both researches. Total research subject include age of 65 years and over was 6 (1 with men, 3 women and 2 with both sexes). Five studies were conducted with healthy, and one with the sick respondents. The strength training program has been in four researches, and a program of strength with aerobic training was represented in the two experimental treatments. Positive research results show all researches in this category. From a total of 15 researches included in this, 4 were with men, 6 women and 5 with both sexes. The health aspect of researches has 3 sick and 12 with healthy subjects. The training program of strength training was concerned with 10 researches, and the combined strength training with aerobic training 5 researches. The positive result of research on the topic: "Effects of intense strength training on cardiovascular endurance", gave 11 researches, and statistically negligible results gave 4 researches. From this we can to conclude the integrity of intensive strength training can cause a positive effect on the cardiovascular system.

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## UTJECAJ INTENZIVNOG TRENINGA SNAGE NA KARDIOVASKULARNU IZDRŽLJIVOST

### Sažetak

*Predmet istraživanja je kardiovaskularna izdržljivost ispitanika starosti od 25 do 75 godina. Problem istraživanja su efekti trenažnog procesa na kardiovaskularnu izdržljivost. Cilj istraživanja je da se utvrdi efekat intenzivnog treninga snage na kardiovaskularnu izdržljivost. Za rješavanje zadataka postavljenih u radu upotrebene su metode teorijske analize kojom se proučava teorija i analiza sadržaja radova stranih autora. Istraživanja koja su prikupljena, obrađena i sagledavana morala su zadovoljiti slijedeće uvjete i to: da su provedena na ispitanicima starosti od 25 do 75 godina, različitog spola, zdravstvenog i psihofizičkog stanja. Proučavani radovi nisu stariji od deset godina. Istraživanjem se želi pokazati statistički značajan efekt intenzivnog treninga snage na kardiovaskularnu izdržljivost u odnosu na starost, spol i zdravstveno stanje ispitanika. Značaj istraživanja je u razumijevanju funkcioniranja i prilagođavanja kardiovaskularnog sistema uslijed treninga snage. Prikupljeni, obrađeni i klasificirani podaci se mogu iskoristiti kao baza za neka nova istraživanja.*

**Ključne riječi:** trening, snaga, srce, tlak i izdržljivost

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## INFLUENCE OF FLEXIBILITY ON SWIMMING RESULTS WITH STUDENTS OF SPORT AND PHYSICAL EDUCATION

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*Original scientific paper*

### Abstract

*Based on the sample of 70 students, on the third year of Faculty of sports and physical education, University of Nis, we applied 6 variables to assess flexibility (predictor system) and 3 variables to assess swimming results (criteria variables). The aim was to determine influence of flexibility on swimming results in 50 m swimming techniques crawl, backstroke and breaststroke. In order to determine flexibility effect on students we applied regression analysis. According to results obtained we can conclude that no significant effect of flexibility on swimming results in examined group of students was found. On the other hand, there is a positive bond between flexibility and achieved results. It is considered that the main reason for such bad result is insufficient adopting of proper quality swimming technique among students. The recommendation is that in practice we should increase the number of practical swimming classes among the students of the Faculty of Sport and Physical Education as well as to perform homogenization of the groups according to the degree of adoption of swimming technique.*

**Key words:** students, flexibility, results, swimming, influence

### Introduction

The swimming implies the ability to maintain the body in water and ability to move through the water with the proper movement of arms, legs and body (Madić & al., 2007). A sport swimming belongs to a group of cyclic type of mono-structural sports (Malacko & Rađo, 2004). Swimming techniques are types of cyclic swimmer's movements during swimming determined by competition rules. In sport's swimming there are four swimming techniques: crawl, breaststroke, backstroke and butterfly (Kapus & al., 2002). Efficiency in any sport activity, including swimming depends on 5 basic factors as follows; 1. performing movement properly (sports technique); 2. energetic capacity 3. Muscle contraction capability; 4. joint mobility and 5. tactics (Milišić, 2003). Joint mobility refers to flexibility. It defines as ability of a man to perform a movement with greatest possible amplitude (Malacko & Rađo, 2004). Optimal flexibility enables proper movement performance in swimming avoiding additional energy consumption to overcome the resistance of the ligaments and tendons that are parts of the joints used for movement. Researching influence and relations of flexibility and other motor skills on the swimming results was conducted by many authors. One of them, Volčanšek (1979), in his research indicates about flexibility significance in swimming results. The author considers that the success in swimming will be possible for swimmers who, besides good coordination abilities, fast frequency motion, success in solving new motor tasks, also have greater flexibility in the shoulder joint. Okičić (1996) in his research concludes that swimmers of younger age category, who have greater flexibility of the shoulder joint, knee and ankle joint, achieve better results, which can help in selection of young swimmers, which is also

confirmed in research Madić & al. (2002). Also, the swimmers junior and senior of international level are characterized by a high degree of flexibility that has a significant correlation with success in (Colman & al., 1992; Rama & al., 2006). Relations and flexibility effects, together with other motor skills, on the swimming results of student's population were also researched by Pivač & Rađo (1996) and Vidović (2000, 2004) and many others. The purpose of this research was to determine flexibility effect on the swimming results 50 m techniques crawl, breaststroke and backstroke of Faculty of Sport and Physical Education students.

### Methods

The sample of respondents consisted of 70 students in third year of Faculty of Sports and Physical Education, Nis. The participants had two classes per week of their regular subject "Swimming". Testing was performed on the last practical class; at the end of second semester of attending the "Swimming" class. The sample of variables consisted of 6 variables for assessment of flexibility as a system of predictor variables, and three variables for assessment of results in swimming as criteria variables. Six measuring instruments was used for flexibility assesment: twist (FISK), a forward bend on the bench (FPRK) a forward bend in straddle (FPRR), plantar foot flexion (FPFS), dorsal foot flexion (FDFS) and arms retroflexion (FRFR). The first 3 tests were taken from the research of Metikoš & al.(1989), and the remaining three from Šoše & Rađo (1998). Three measuring instruments were used for evaluation of swimming results: the swimming result for 50 m crawl (PK50), swimming result for 50 m backstroke (PL50) and swimming result for 50 m breaststroke (PP50).

The measuring was performed in the gym and the pool of the Sports Center "Čair" in Niš. All measuring were conducted at the end of the third year of studies that consisted, among other things, of theoretical and practical classes of swimming. Practical class was organized as one swimming class once a week 90 min long. All the results obtained were processed in the program *Statistica 6.0*. The basic parameters of descriptive statistics were calculated for all variables AS-arithmetic mean, R- span, MAX maximum result, Min-minimum result; SD standard deviation. Results distribution symmetry was evaluated based on the values of Skewness (Skew) and results distribution uniformity based on the values of kurtosis (Kurt).

By using the Kolmogorov-Smirnov test it was determined whether the distribution of results in applied variables has a statistically relevant variation from the normal distribution (max D and K-S test). Correlation between applied variables was determined by coefficients of linear correlation presented in intercorrelation variable matrix. In order to determine effect of entire predictor variable system on criteria variables, regression analysis was applied and following statistic parameters were calculated: multiple correlation coefficients (R), determination coefficient, ( $R^2$ ), F-test result (F), statistical relevance (p). For determining the influence of each individual variable in regression analysis we calculated: partial correlation coefficients (Part-R), Correlation coefficients (R), standardized coefficients of partial regression (Beta), t-test results (t) and statistical relevance (p). For statistical relevance we used the relevance level up to 0.05 ( $p \leq 0.05$ ).

## Results

Table 1. presents the values of descriptive statistics basic parameters, the values of Skewness, Kurtosis and Kolmogorov-Smirnov test. The values of Kolmogorov-Smirnov test indicate that in all applied variables, result distribution do not have statistically relevant variations from normal distribution, since the greatest difference between the relative and the theoretical cumulative frequency in each variable (max D) is lower than the constant (K-S test) 0.16. This enables using the obtained results for further analysis.

Table 1. Results of descriptive statistics

| Variable        | AS    | SD    | Min   | Max   | Span  | Skew  | Kurt  | max D |
|-----------------|-------|-------|-------|-------|-------|-------|-------|-------|
| PK50            | 44,50 | 7,79  | 30,64 | 70,1  | 39,46 | 0,81  | 1,54  | 0,08  |
| PL50            | 61,69 | 11,37 | 40,00 | 98,6  | 58,60 | 0,93  | 1,02  | 0,09  |
| PP50            | 64,36 | 11,29 | 46,00 | 92,4  | 46,40 | 0,54  | -0,36 | 0,09  |
| FISK            | 80,90 | 14,52 | 42,00 | 110,0 | 68,00 | -0,39 | -0,34 | 0,15  |
| FPRK            | 40,24 | 7,29  | 15,00 | 54,0  | 39,00 | -0,58 | 1,02  | 0,08  |
| FPRR            | 73,96 | 11,41 | 48,00 | 112,0 | 64,00 | 0,84  | 2,13  | 0,11  |
| FPFS            | 46,23 | 6,82  | 25,00 | 60,0  | 35,00 | -0,19 | 0,53  | 0,10  |
| FDfs            | 20,41 | 4,72  | 10,00 | 29,0  | 19,00 | -0,26 | -0,29 | 0,09  |
| FRFR            | 24,26 | 9,73  | 6,00  | 47,0  | 41,00 | 0,10  | -0,59 | 0,07  |
| K-S test = 0.16 |       |       |       |       |       |       |       |       |

Table 2 presents the results of inter-correlation matrix of applied variables, and all statistically relevant variables were marked with **bold**. There is statistically relevant and high correlation among all 3 variables for swimming results evaluation. There is also a statistically relevant correlation among certain variables for evaluation of flexibility. There is no statistically relevant correlation between the variables for evaluation of flexibility as a predictor system and the variables for evaluation of swimming results, except in variables FRFR and PL50 (-0.35). The negative sign in this case represents a positive correlation considering the fact that these two variables are inversely scaled. Results of regression analysis in table 3 indicate there is no statistically relevant influence of entire predictor variable system for flexibility assessment on criteria variable swimming result 50 m with crawl ( $p = 0.59$ ). This is also confirmed by low values of multiple correlation coefficient ( $R = 0.26$ ) and determination coefficient ( $R^2 = 0.07$ ). Individually, out of each applied predictor variables, the statistically relevant influence onto the criterion variable has the predictor variable FRFR ( $p = 0.05$ ). Since the entire system of predictor variables has no statistically relevant influence onto the criterion variable, then the influence of predictor variable FRFR is considered to be random. Regression analysis results in Table 4. Indicate that there is no statistically relevant influence of predictor system of variables for evaluation of flexibility onto the 50 m results with backstroke technique ( $p = 0.11$ ). This is also confirmed by low values of multiple correlation coefficient ( $R = 0.38$ ) and determination coefficient ( $R^2 = 0.15$ ). Individually, out of each applied predictor variables, the statistically relevant influence onto the criterion variable has the predictor variable FRFR ( $p = 0.00$ ). Since the entire system of predictor variables has no statistically relevant influence onto the criterion variable, then the influence of predictor variable FRFR is considered to be random. Regression analysis results in Table 5. Are indicating that there is no statistically relevant influence of the entire system of predictor variables for evaluation of flexibility onto the criterion variable *swimming result 50 m breaststroke* ( $p = 0.75$ ). This is also confirmed by low values of multiple correlation coefficient ( $R = 0.23$ ) and determination coefficient ( $R^2 = 0.05$ ).

Table 2. *Inter-correlation matrix of applied variables*

| Variable | PK50        | PL50         | PP50        | FISK         | FPRK         | FPRR         | FPFS         | FDFS        | FRFR         |
|----------|-------------|--------------|-------------|--------------|--------------|--------------|--------------|-------------|--------------|
| PK50     | 1.00        | <b>0.71</b>  | <b>0.60</b> | -0.04        | 0.09         | 0.04         | 0.05         | 0.04        | -0.21        |
| PL50     | <b>0.71</b> | 1.00         | <b>0.64</b> | -0.07        | 0.02         | -0.04        | -0.10        | 0.12        | <b>-0.35</b> |
| PP50     | <b>0.60</b> | <b>0.64</b>  | 1.00        | 0.07         | 0.07         | 0.08         | 0.07         | 0.15        | -0.10        |
| FISK     | -0.04       | 0.07         | 0.07        | 1.00         | <b>-0.33</b> | <b>-0.26</b> | <b>-0.36</b> | -0.05       | -0.14        |
| FPRK     | 0.09        | 0.02         | 0.07        | <b>-0.33</b> | 1.00         | <b>0.61</b>  | <b>0.28</b>  | <b>0.25</b> | 0.21         |
| FPRR     | 0.04        | -0.04        | 0.08        | <b>-0.26</b> | 0.61         | 1.00         | <b>0.31</b>  | 0.13        | <b>0.33</b>  |
| FPFS     | 0.05        | -0.10        | 0.07        | <b>-0.36</b> | <b>0.28</b>  | <b>0.31</b>  | 1.00         | 0.11        | 0.13         |
| FDFS     | 0.04        | 0.12         | 0.15        | -0.05        | <b>0.25</b>  | 0.13         | 0.11         | 1.00        | -0.10        |
| FRFR     | -0.21       | <b>-0.35</b> | -0.10       | -0.14        | 0.21         | <b>0.33</b>  | 0.13         | -0.10       | 1.00         |

Table 3. *Regression analysis for 50 m crawl Swimming result (PK50) variable*

| Variable                                                        | R     | Part-R | Beta  | t (63) | p    |
|-----------------------------------------------------------------|-------|--------|-------|--------|------|
| FISK                                                            | -0.04 | -0.01  | -0.01 | -0.08  | 0.94 |
| FPRK                                                            | 0.09  | 0.08   | 0.10  | 0.62   | 0.54 |
| FPRR                                                            | 0.04  | 0.04   | 0.06  | 0.35   | 0.73 |
| FPFS                                                            | 0.05  | 0.04   | 0.04  | 0.30   | 0.77 |
| FDFS                                                            | 0.04  | -0.02  | -0.02 | -0.18  | 0.86 |
| FRFR                                                            | -0.21 | -0.25  | -0.26 | -2.01  | 0.05 |
| <b>R = 0.26, R<sup>2</sup> = 0.07, F(6.63) = 0.78, p = 0.59</b> |       |        |       |        |      |

Tabela 4. *Regression analysis for 50 m backstroke Swimming result (PL50) variable*

| Variable                                                        | R     | Part-R | Beta  | t (63) | p    |
|-----------------------------------------------------------------|-------|--------|-------|--------|------|
| FISK                                                            | 0.07  | 0.04   | 0.04  | 0.30   | 0.76 |
| FPRK                                                            | 0.02  | 0.06   | 0.08  | 0.49   | 0.63 |
| FPRR                                                            | -0.04 | 0.05   | 0.07  | 0.43   | 0.67 |
| FPFS                                                            | -0.10 | -0.08  | -0.08 | -0.65  | 0.52 |
| FDFS                                                            | 0.12  | 0.07   | 0.07  | 0.57   | 0.57 |
| FRFR                                                            | -0.35 | -0.35  | -0.37 | -2.93  | 0.00 |
| <b>R = 0.38, R<sup>2</sup> = 0.15, F(6.63) = 1.82, p = 0.11</b> |       |        |       |        |      |

Tabela 5. *Regression analysis for 50 m breaststroke Swimming result (PP50) variable*

| Variable                                                        | R     | Part-R | Beta  | t (63) | p    |
|-----------------------------------------------------------------|-------|--------|-------|--------|------|
| FISK                                                            | 0.07  | 0.11   | 0.12  | 0.91   | 0.37 |
| FPRK                                                            | 0.07  | 0.03   | 0.04  | 0.22   | 0.83 |
| FPRR                                                            | 0.08  | 0.07   | 0.08  | 0.52   | 0.60 |
| FPFS                                                            | 0.07  | 0.08   | 0.08  | 0.60   | 0.55 |
| FDFS                                                            | 0.15  | 0.11   | 0.12  | 0.89   | 0.37 |
| FRFR                                                            | -0.10 | -0.11  | -0.12 | -0.88  | 0.38 |
| <b>R = 0.23, R<sup>2</sup> = 0.05, F(6.63) = 0.58, p = 0.75</b> |       |        |       |        |      |

## Discussion and conclusion

The obtained results indicate that there is no relevant influence of predictor system of variables for evaluation of flexibility onto the predictor variables (swimming results for 50 m crawl, backstroke and breaststroke) in students that took part in this research. The results obtained in this way are similar to the ones obtained in the one researching relation of motor skills with styled forms of movements in swimming the techniques crawl, back and breast (Vidović, 2000; 2004).

The author determined, as well, that the flexibility is not in relevant correlation with breaststroke swimming technique, while the correlation of flexibility and swimming technique crawl is statistically relevant, but of low values. Pivač & Rađo (1996) determined that flexibility has a relevant influence on students' degree of success in acquiring the swimming techniques. Unlike our own, the results of many other researches confirmed the influence of flexibility onto the swimming results, primary in population of swimmers, but in students as well.

The reason we obtained this type of results in this research is inadequately acquired and mastered swimming technique, indicated by the swimming results themselves that are below the expected (Table 1). If the swimming technique is not properly acquired the influence of flexibility and other motor skills onto the swimming efficacy is reduced and limited (Okičić et al., 2007). It is obvious that one 90 minutes long swimming class per week is not enough for the students to acquire and master the swimming techniques properly. In general it can be concluded that in students of third year of Faculty of Sport and Physical Education in

Nis the existence of relevant influence of the flexibility onto the swimming results (techniques crawl, backstroke and breaststroke) wasn't determined. We believe that the number of practical swimming classes where the swimming techniques would be practiced and mastered should be increased. There is also an issue of higher criteria when it comes to selection of future students of Faculty of Sport and Physical Education that should be introduced by making swimming norms more strict. Redefining of the teaching process in swimming exercises towards homogenization of the groups was also suggested.

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## UTJECAJ GIBLJIVOSTI NA PLIVAČKE REZULTATE KOD STUDENATA TJELESNOG ODGOJA

### **Sažetak**

Na uzorku od 70 studenata treće godine Fakulteta sporta i fizičkog vaspitanja Univerziteta u Nišu, primjenjeno je 6 varijabli za procjenu fleksibilnosti (prediktorski sistem) i 3 varijable za procjenu rezultata u plivanju (kriterijske varijable). Cilj je bio da se utvrdi utjecaj fleksibilnosti na rezultate u plivanju na 50 metara tehnikama kraul, leđno i prsno kod studenata. Za utvrđivanje utjecaja fleksibilnosti na rezultate u plivanju korištena je regresiona analiza. Na osnovu dobivenih rezultata može se zaključiti da nije utvrđen značajan utjecaj fleksibilnosti na rezultate plivanja kod ispitivane grupe studenata. S druge strane, kod plivača takmičara postoji pozitivna veza između fleksibilnosti i ostvarenih rezultata. Smatra se da su glavni razlozi ovako dobivenih rezultata nedovoljno pravilno i kvalitetno usvojene plivačke tehnike od strane studenata. Preporuka je da se u praksi poveća broj praktičnih sati plivanja kod studenata Fakulteta sporta i fizičkog vaspitanja kao i da se izvrši homogenizacija grupa prema stepenu usvojenosti plivačkih tehnika.

**Ključne riječi:** studenti, fleksibilnost, rezultati, plivanje, utjecaj

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**RELIABILITY AND FACTORIAL VALIDITY OF POWER TESTS FOR HANDBALL PLAYERS****Dinko Vuleta jr.<sup>1</sup>, Goran Sporiš<sup>1</sup>, Munir Talović<sup>2</sup> and Eldin Jelešković<sup>2</sup>**<sup>1</sup> Faculty of Kinesiology, Zagreb, Croatia<sup>2</sup> Faculty of Sports and Physical Education, Sarajevo, Bosnia & Herzegovina*Original scientific paper***Abstract**

The main purpose of this study was to define reliability and factorial validity of four field specific handball tests used for the assessment of explosive (throwing) power of elite handball players. The subjects were 18 top level Croatian national handball players. The participants were tested during the middle of the competitive season. Three throws were measured for each test (R4M, R6M, R9MRS and R9MJS). The reliability was assessed through the AVR, ICC and Cronbach's  $\alpha$  coefficients, and the validity through the correlations obtained by the principal components factor analysis. The R6M, R9MRS and R9MJS tests had high reliability coefficients ( $\alpha = 0.93, 0.93$  and  $0.91$ ). The principal components analysis extracted one statistically significant component. The R4M test had the lowest correlation with the component ( $r = 0.52$ ), and the other three tests had correlation coefficients between  $0.88$  and  $0.93$ . The results of the study proved that the most reliable and appropriate tests to assess the explosive (throwing) power of handball players are the R6M and R6MRS tests.

**Key words:** handball, field specific tests, explosive (throwing) power**Introduction**

A handball match encompasses a large number of different movement patterns, which are applicable in different situations. 134 typical technical-tactical movement patterns have been identified as most common during a handball match (Vuleta et al., 1999). Logically the most important between those are the ones including ball handling, as well as throwing the ball either to other team players or shooting towards to the opponent's goal from different positions on the court. In almost all of the cases shooting the ball towards the opponent's goal requires a high level of physical fitness, especially in terms of explosive power. When it comes to backcourt players which are positioned at a distance of 9 to 12 meters from the goal ball throwing explosive power comes on top of the priority list, because to score they need to execute strong and fast shots. In addition, approximately one half of all shots during a handball match are executed from the backcourt position (Šibila, 2004). Therefore developing explosive power is one of the most important issues during the preparation of handball players in the pre-season and in-season period. The ability to maintain or increase explosive power and performance during the competitive season is also an important consideration due to the increased demands of technical and tactical training and competition. Therefore in-season strength and conditioning programs are often designed to maintain adequate levels of strength and power over several months (Graham, 2002; Rajić et al., 2004; Newton et al., 2006; Vuleta et al., 2009). There has been a significant amount of studies concerning the effects of different training programs aimed to increase throwing power in handball (Edwards Van Muijen et al., 1991; Barata, 1992; Hoff & Almåsbaek, 1995; Gorostiaga et al., 1999; Gløsen, 2001; Van Den Tillaar, 2004).

The same as in other sports which have similar throwing movement patterns (Wooden et al., 1992; Newton et al., 1994; Lachowetz et al., 1998; McEvoy et al., 1998). The studies on training effects can be divided into 4 categories. The first category encompasses specific resistance training with an overload of velocity, the second category includes specific resistance training with an overload of force. Specific resistance training with a combination of overload of force and velocity form the third category, and the last category includes general resistance training according to the overload of force (Van Den Tillaar, 2004). Due to the importance of explosive power in handball it is very important to construct high quality tests to assess the explosive power of handball players. To the author's knowledge studies regarding the reliability and factorial validity of such tests are rare, especially concerning the assessment of explosive (throwing) power with top level handball players. The main purpose of this research was to define reliability and factorial validity of four field specific handball tests used for the assessment of explosive (throwing) power of elite handball players in a movement that involved the upper body, trunk, and lower extremities in its execution.

**Methods***Subjects*

The research was conducted on 18 top level junior Croatian National team handball players (Mean  $\pm$  SD; age =  $18.52 \pm 0.77$  years, handball experience =  $7.37 \pm 2.51$ , height =  $187.88 \pm 6.25$ , weight =  $87.13 \pm 11.54$ ) which won a gold medal on the European Championship in 2006 and a silver medal on the World Championship in 2007.

All of the subjects were highly trained, internationally experienced and highly motivated. As part of the testing process, each subject was asked to give his written informed consent following an explanation of the nature and purpose of the experiment and of the risks associated with participation. This explanation was in compliance with the Declaration of Helsinki. All experimental procedures were approved by the Ethics Committee of the School of Kinesiology, University of Zagreb.

#### *Testing Procedure*

Testing was conducted during the middle of the participants' competitive season 2007/2008. The protocol was explained to the subjects, and they then watched a demonstration of the four ball throws. This was followed by a practice session. Subjects were given as many practice throws as they desired until they were able to make 3 consecutive throws to within of their fastest throw. This was followed by a rest period (typically 20 minutes) before completing the test protocol. The testing consisted of four different types of ball throws that involved a movement pattern similar to that of a throwing a ball or shooting on a goal during a handball match. The ball throws were performed using standard size 3 hand ball which size and mass is regulated by IHF/EHF Rules of the handball game (ball weight 425 g, - 475 g,, ball radius = 58 - 60 cm). Before the testing, the subjects performed their normal warm-up. They were also given several warm-up throws, followed by 3 measured trials in which they attempted to throw the ball as fast as possible. Each throw was measured for speed in kilometers per hour (kph). The speed of the ball was captured with a radar (Stalker ATR, Professional radar, Applied Concepts Inc., Plano, TX U.S.A.) positioned behind the goal. Each trial was followed by approximately 30 seconds of passive rest before the subsequent trial. Testing was conducted so that each subject first performed one throw three measured trials, and when all subjects completed the test the whole group moved to the next test.

#### *Radar 4m throw (R4M)*

The handball player was seated on the goalkeeper restraining line with his face turned in the direction of the goal. Then he was given the ball to execute a handball throw. The throw had to be completely executed with the use of the dominant arm and the ball had to be thrown in the goal. During the execution of the handball throw the player was allowed to bend his legs, but was not allowed to stand up on his feet.

#### *Radar 6m throw (R6M)*

The handball player was standing on the goal-area line straight in front of the goal with his face turned in the direction of the goal. The player had to stand in a diagonal stance. Then he was given the ball to execute a handball throw. The player was not allowed to make a step in any direction during the throw or after the ball has been thrown. The throw had to be completely executed with dominant arm and the ball had to be thrown in to the goal.

#### *Radar 9m run up shot (R9MRS)*

The handball player was standing at a distance of 12m from the goal with his face turned in the direction of the goal. Then he was given the ball to execute the basic handball three steps run up throw. The ball had to be thrown with the use of one arm and the ball had to be thrown in the goal. The player had to execute a throw just before the free throw line and was not allowed to make a step inside the area of 9-meters after the ball has been thrown.

#### *Radar 9M Jump Shot (R9MJS)*

The handball player was standing at a distance of 20m from the goal with his face turned in the direction of the goal. Then he was given the ball and had to dribble towards the goal and when he saw fit he had to do a three step run up by holding the ball, after which he executed the jump shot. The ball had to be thrown with the use of one arm and the ball had to be thrown in the goal. The player had to execute a throw just before the free throw line and was allowed to land inside the area between the free throw line and the outer goal line after the ball has been thrown.

#### *Statistical Analyses*

The acquired data was analyzed through the use of the statistical package Statistica for Windows (v7.0, Statsoft, Tulsa, OK, USA). Means and standard deviations were determined for each variable as well as measures of skewness and kurtosis. A significance level of  $p$ , 0.05 was selected. Pearson correlation coefficients ( $r$ ) were used to determine the strength of association between each of the variables and their relationship. The reliability was measured by the determination of the average intertrial correlation (AVR), interclass correlation coefficient (ICC) and Cronbach's alpha reliability coefficient ( $\alpha$ ). The within-subject variation for the tests was determined by calculating the coefficient of variation (CV) (Hopkins, 2000). The normality of the distributions of the tests was determined by the use of the Kolmogorov-Smirnov test. To determine the factor validity of new explosive (throwing) power tests used in handball (R4M, R6M, R9MRS and R9MJS), an inter-correlation matrix of four tests was factorized using a principal components factor analysis. The number of significant factors was determined by the Guttman-Kaiser criterion (Nunnally & Bernstein, 1994), which retains components with eigenvalues ( $\lambda$ ) of 1.0 or greater. The structure matrix was used to determine the factor validity.

#### **Results**

All the variables had normally distributed data (R4M -  $\max D = 0.19$ ,  $p > 0.20$ ; R6M -  $\max D = 0.14$ ,  $p > 0.20$ ; R9MRS -  $\max D = 0.19$ ,  $p > 0.20$ ; R9MJS -  $\max D = 0.14$ ,  $p > 0.20$ ). The reliability  $\alpha$  coefficients of the mentioned tests, carried out three times, were very high and varied between 0.89 and 0.93. Of all the explosive (throwing) power tests the R6M, and R9MRS had the same and the greatest reliability ( $\alpha = 0.93$ ).

Table 1. Descriptive statistics for all tests.

|              | Mean $\pm$ SD    | Min   | Max    | Range | Skew  | Kurt  |
|--------------|------------------|-------|--------|-------|-------|-------|
| <b>R4M</b>   | 58.96 $\pm$ 3.61 | 52.70 | 65.33  | 12.63 | 0.46  | -0.55 |
| <b>R6M</b>   | 85.36 $\pm$ 6.87 | 66.03 | 95.37  | 29.33 | -1.18 | 2.55  |
| <b>R9MRS</b> | 92.61 $\pm$ 5.31 | 81.70 | 101.63 | 19.93 | -0.54 | 0.13  |
| <b>R9MJS</b> | 90.06 $\pm$ 4.31 | 82.13 | 97.97  | 15.83 | -0.33 | -0.12 |

Mean - arithmetic mean, SD - standard deviation, Min - minimal result, Max - maximal result, Skew - skewness, Kurt - kurtosis

The same tests also had the greatest ICC. The within subject variation ranged between 4.79% and 8.05%. The lowest value of the CV was found with R9MJS test. The AVR ranged between 0.68 and 0.84. The greatest value of the AVR was noted with the R4M test (0.84) and the lowest value was noted with the R9MJS test (0.68).

Table 2. Reliability statistics for all tests.

|              | $\alpha$ | AVR  | ICC  | CV    |
|--------------|----------|------|------|-------|
| <b>R4M</b>   | 0.89     | 0.84 | 0.89 | 6.17% |
| <b>R6M</b>   | 0.93     | 0.83 | 0.93 | 8.05% |
| <b>R9MRS</b> | 0.93     | 0.80 | 0.93 | 5.73% |
| <b>R9MJS</b> | 0.91     | 0.68 | 0.91 | 4.79% |

$\alpha$  - Cronbach's alpha, AVR - average intertrial correlation, ICC - interclass coefficient of correlation, CV - coefficient of variation

Table 3. Intercorrelation matrix of all tests.

|              | <b>R4M</b> | <b>R6M</b> | <b>R9MRS</b> | <b>R9MJS</b> |
|--------------|------------|------------|--------------|--------------|
| <b>R4M</b>   | 1.00       | 0.23       | 0.40         | 0.35         |
| <b>R6M</b>   | 0.23       | 1.00       | 0.83*        | 0.73*        |
| <b>R9MRS</b> | 0.40       | 0.83*      | 1.00         | 0.72*        |
| <b>R9MJS</b> | 0.35       | 0.73*      | 0.72*        | 1.00         |

\* Significant correlation at 0.05 level (2 tailed)

Correlation coefficients between tests ranged from 0.23 to 0.83. The lowest correlation was found between the R4M test and R6M test ( $r = 0.23$ ) and the highest between R6M test and R9MRS test ( $r = 0.83$ ). Statistically significant correlations were determined between the R6M test and R9MRS test, between R6M test and R9MJS test, and R9MRS test and R9MJS test. The principal components factor analysis of the four explosive (throwing) power tests resulted in the extraction of one significant component. The principal component explained 67.60% of the total variance of the four tests.

Table 4. Eigenvalues ( $\lambda$ ) and percentage of explained variance for all principal components.

| Comp.     | $\lambda$    | % variance   | Cum. %       |
|-----------|--------------|--------------|--------------|
| <b>1*</b> | <b>2.704</b> | <b>67.60</b> | <b>67.60</b> |
| <b>2</b>  | 0.837        | 20.93        | 88.53        |
| <b>3</b>  | 0.312        | 7.79         | 96.33        |
| <b>4</b>  | 0.147        | 3.67         | 100.00       |

\*Significant principal component extracted

The correlation coefficients with the component varied between 0.52 and 0.93. The R4M test had the lowest correlation coefficient with the component ( $r = 0.52$ ).

But all the other three explosive power tests had correlation coefficients higher than 0.88, and they varied between 0.88 and 0.93. The R4M test had high correlation with the second principal component (0.85), however the second extracted component is not statistically significant.

Table 5. Correlation coefficients of the tests with the extracted principal components.

|              | Component 1* | Component 2 |
|--------------|--------------|-------------|
| <b>R4M</b>   | 0.52         | 0.85        |
| <b>R6M</b>   | <b>0.90</b>  | 0.31        |
| <b>R9MRS</b> | <b>0.93</b>  | 0.09        |
| <b>R9MJS</b> | <b>0.88</b>  | 0.10        |

\*Significant principal component

## Discussion and conclusion

If the movement pattern that is used in the four tests is observed then it is possible to conclude that in all of the cases it is movement that is highly automated with handball players. Nevertheless, to avoid the motor learning effect each of the subjects had the opportunity to make as many trial throws as possible to achieve their maximal result. Small unsystematic variations were noted in the average values of the trials of all throws. According to the values of SD, Range, Skew, and Kurt the sensitivity of tests are at a satisfying level. The mean results obtained from the tests (Table 1.) point out the fact that in the R6MRS test where the players had to throw to ball from the ground after the three step run up sequence had the highest value (92.61 kph). It is surprising that the players did not achieve the highest score in the R9MJS test since the players were allowed a larger distance to speed up and to generate a larger amount of kinetic energy than in the R6MRS test.

This can be explained with fact that junior players have not yet evolved their full potential to transfer the kinetic energy through the kinetic chain at larger movement speeds due to the inadequate level of explosive (throwing) power. All explosive (throwing) power tests have high AVR, ICC and  $\alpha$  reliability coefficients (Table 2.). The reliability values are the highest in the R6M and R6MRS tests, which can be labeled as the most reliable tests to assess the explosive (throwing) power of handball players (Table 2.). Within subjects variations (CV) are high but still acceptable (Table 2.). If the coefficients of correlation between the tests are observed, it can be stated that higher and statistically significant relationships exist between tests that have a similar movement pattern (Table 3.). The highest correlation was determined between the R6M and R9MRS tests ( $r = 0.83$ ) what points to the fact that in both of the tests a similar movement pattern was used. There was only a slight difference in the execution of the R9MRS test in which the player was allowed a three step run up sequence before the throw, but the kinetic chain of the throw remained almost the same as with the R6M test.

The principal component's analysis resulted in the extraction of one statistically significant component, which extracted 67.60% of the total variance of all four tests. Three of four tests had very high correlations with the first component ( $r=.88-.93$ ), and only the R4M test had a high correlation with the second principal component ( $r= 0.85$ ) which is not statistically significant. The first principal component can be named as the handball specific explosive (throwing) power factor. The R9MRS test showed the highest correlation with this factor ( $r = 0.93$ ), therefore it is evident that the test has the best factorial validity among all analyzed tests. The R4M test had a low correlation with the first principal component ( $r = 0.52$ ) which can be explained with the fact that the movement pattern used to throw the ball in this test excludes the lower body as well as the movement through space which is often used to generate additional kinetic energy that would later be transferred through the kinetic chain to the ball by the application of right movements in different phases of the handball throw to achieve the fastest throw as possible (Pori et al., 2005.). The optimal functioning of the kinetic chain is based on the energy transfer from the proximal to the distal segments and to the ball (Muller, 1982; Bon, Šibila & Erčulj, 1997,). The kinetic chain of a handball throw has two important characteristics which should be considered. The first is the peak joint centre speed, and the second which is directly effected by the first, the speed of the thrown ball. In a handball jump shot the peak joint speed, which is relevant for the first part of the throw increases in the next order: first the hip ( $v = 4.92$  m/s), then the shoulder ( $v = 5.59$  m/s) followed by the elbow ( $v = 8.92$  m/s) and the wrist ( $v = 16.45$  m/s), after which the thrown ball moved with the speed of 25.74 m/s, or approximately 92.66 kph (Šibila, et al., 2005).

It is obvious that such result regarding the speed of the thrown ball is in accordance with the results of this study. In addition to the previous statement the means of the other three tests (R6M, R9MRS and R9MJS) had higher values than the R4M test (Table 1.). Although the second principal component is not statistically significant it can also confirm the previous statement, with the fact that a high correlation of the R4M test with the principal component (0.85) allows the assumption that the factor could be labeled as upper body explosive (throwing) power factor. However the principal component cannot be interpreted because at least 3 tests had to have a correlation higher than 0.50 with the component (Nunnally & Bernstein, 1994). Future researches in this field should be conducted on the top level senior handball players and if it is possible on a larger sample. The authors also believe that in the future it is of great importance to assess the explosive (throwing) power of top level handball players with tests that are even more specific for example different tests for each playing position (wing players, backcourt players, pivot player) which imply different movement patterns.

This study determined the reliability and factorial validity of 4 specific handball tests. The results of this study point out that all of the 4 observed tests to assess explosive (throwing) power and are reliable for estimating the explosive power of handball players. The R6M, R6MRS and R9MJS tests are proven the most reliable and factorial valid between the selected tests and therefore the most appropriate to assess the explosive power of handball players. Through the obtained results it can also be concluded that R4M test is not appropriate for general use to assess explosive (throwing) power because it excludes the complete throwing kinetic chain.

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## POUZDANOST I FAKTORSKA VALJANOST TESTOVA ZA PROCJENU EKSPLOZIVNE SNAGE RUKOMETASA

### Sažetak

Svrha ovog istraživanja bila je utvrditi pouzdanost i faktorsku valjanost testova za procjenu eksplozivne snage tipa bacanja kod rukometaša. Uzorak ispitanika bili su 18 vrhunskih rukometaša članova Hrvatske nacionalne selekcije. Ispitanici su testirani u natjecateljskom periodu. Tri pokušaja su zabilježena kod svakog testa (R4M, R6M, R9MRS and R9MJS). Pouzdanost je procijenjena kroz utvrđivanje Cronbachove  $\alpha$ , interklasnog koeficijenta korelacije i prosječnog koeficijenta korelacije između pokušaja. Kod testova R6M, R9MRS i R9MJS utvrđeni su visoki koeficijenti pouzdanosti ( $\alpha = 0.93$ ,  $0.93$  and  $0.91$ ). Faktorskom analizom metodom najznačajnijih komponenti utvrđena je jedna statistički značajna glavna komponenta. Test R4M ima najmanju korelaciju s prvom glavnom komponentom ( $r = 0.52$ ), a ostala tri testa imaju koeficijente korelacije između  $0.88$  i  $0.93$ . Temeljem rezultata istraživanja utvrđeno je da su najpouzdaniji i najprikladniji testovi za procjenu eksplozivne snage tipa bacanja kod rukometaša testovi R6M, R6MRS i R9MJS.

**Ključne riječi:** rukomet, specifični testovi, eksplozivna snaga tipa bacanja

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## THE INFLUENCE OF HALF AND FULL DAY STAY ON MOTOR ABILITIES OF PRE SCHOOL CHILDREN

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*Original scientific paper*

### Abstract

*The goal of this research was to determine certain differences in motor abilities of preschool children which are generated under the influence of two different times and daily structures of stay in preschool institutions. This research has transversal character. It was conducted in kindergarten "Dečja radost" in Svilajnac, Republic of Serbia, with the sample of 118 children divided into four characteristic subsamples – according to gender and time of stay in preschool institutions: 26 male examinees with half day stay, 35 male examinees with full day stay, 23 female examinees with half day stay and 34 female examinees with full day stay. Motor abilities were evaluated by appliance of six standardized movement tasks. In the processing of data the following procedures were used: descriptive statistics, multivariate analysis of variance, univariate analysis of variance, discriminative analysis. By the use of multivariate analysis of variance and discriminative analysis it was noted that there is statistically significant difference and clearly defined border between male and female examinees of full day stay and half day stay in relation to their motor abilities. By the use of univariate analysis of variance statistically significant difference was noted in four out of six and for female examinees two out of six researched variables. The improvements in motor abilities statistically validate the idea that full day stay in preschool institutions is educationally more efficient, which should be checked by further empirical research.*

**Key words:** influence, half day stay – full day stay, motor abilities, preschool age

### Introduction

The basic assumptions of education of pre-school children aged 3 to 7 start with a child as a physical, cognitive and social and affective being who is active in the process of education. The basics of curriculum of pre-school education were established in 1996 and were applied in 1997/1998. The process of education is based on positive child's motivation, educational programs which respect developing and age conditions of a child, as well as on evaluation of the results (Džinović-Kojić, 2002). In the program the concept was designed in two models – model A and model B. Model A is an opened system of preschool education and it consists of: program introduction, goals, principles, planning and evaluation of educational work and the role of a pedagogue as a practical person, creator, researcher of his own practice. Model B is based on positive experiences of educational practice and it consists of: principles, goals, activity system, organization of life and educational work, cooperation with family and local community. Pilot program based on the model of Maria Montessori which implies education and upbringing of children through work and education of practical life matters in heterogeneous groups, where younger children learn from older children, with the help of specially designed didactic materials, was accepted in some of our preschool institutions. The city secretariat for education of the city of Belgrade made a decision that from 1972/73 they start with constant monitoring of physical development and physical abilities of students in primary and secondary schools (Ivanić, 1996).

The monitoring started in 1983. Three batteries of tests were conducted according to the students' age. Battery for preschool children consisted of: throwing tennis ball, long jump from a stand, throwing of medicine ball, and shuttle run 3x10 meters. In 1995/1996 school year there were some changes in battery of motor tests for monitoring preschool children so that throwing the tennis ball was replaced by bent arm hang, shuttle run 3x10 meters was replaced with a 30 meter running from high start. There are two methodological approaches how to determine physical abilities in preschool education. Numeric approach, which is based on validate metric procedures of testing and number expression of the results of evaluation with the use of international physical units: meter, second and kilogram. The other approach is, so called, descriptive evaluation of motor status where subjective judgment about movement is present and values are expressed in descriptive categories. For this purpose a special scale of development of motor abilities can be used invented by an American scientist M. Gutrich (Gutrich, according to Watson, 1973.) This scale consists of fourteen stages of motor ability development which are incorporated in motor manifestations of each subject in movement tasks. Gutrich divided these fourteen stages into four development categories and these are: child does not make a move – mark 1 and 2; skill in forming phase – mark 3, 4, 5, 6 and 7; achievement of basic movements – mark 8, 9, and 10; and skillful performance with variations in use – mark 11, 12, 13, and 14.

In his research (Perić, 1991) presented there is no substantial qualitative difference between the two methodological systems that imply motor status of preschool children. In kindergarten "Dečja radost" in Svilajnac preschool children attend education programme during half day stay and a full day stay according to model A. A half day stay exists as a form of preparatory groups for children in the year before starting school. A full day stay implies the influence of preschool education which lasts three and more years, during the whole day. A half day stay implies influence of preschool education only one year before starting school and only 'til afternoon. The basic idea of this work is that different lengths of stay in preschool institutions can differently affect motor abilities of preschool children. Research of anthropometric characteristics and motor abilities is the most frequent interest in physical culture. Scientists usually do not evaluate children younger than seven, because children cannot understand the performance of motor tasks, which is influenced by the end of myelinization of nervous system which occurs during that time and impacts the length of a child's attention. In researches (Stanković, 1976; Zdravković, 1978; & Kunderat, 1979) it was proved that daily physical exercise significantly affects physical abilities of preschool children. On the sample of examinees between age 6 and 10 (Bala, 1981) did not prove the existence of higher motor dimensions so we can speak only about general factor of motor abilities of preschool children. In this work, (Perić, 1991) with appliance of adequate statistical procedures, eleven motor tasks were determined, which contain all methodological characteristics of standardized tests that would help creating the battery which would be implied in preschool physical education. Depending on the time spent in preschool institutions (Bunčić, 2005) presented the differences in physical abilities of male and female students. The sample of children (Sabo, 2005) starting school also indicates that the boys and girls who attended kindergarten from nursery age until starting school have better results in motor compared to boys and girls who attended kindergarten from the oldest groups until starting school. By comparing the effects of physical education (Bunčić, 2005), performed in experimental groups according to model A and model B, which lasted three years and the effects of physical education in control group which was not involved in institutional physical education before experimental treatment, states best results in the development of motor and motor abilities at children who had physical education according to model A. The *aim* of this research was to determine eventual differences in motor abilities of preschool children which start under the influence of the effects of two different times spend in kindergarten and daily structures of stay in preschool institutions.

## Methods

This was empirical research with transversal character, conducted in kindergarten "Dečja radost" in Svilajnac, Republic of Serbia in 2008.

Motor abilities were evaluated during regular morning activities according to the methodology for monitoring physical development and physical abilities of children and youth (Ivanić, 1996). The sample of examinees was formed in relation to the subject and goal, and it was influenced by expert, organizational and material conditions of realization of half day stay and full day stay in kindergarten "Dečja radost" in Svilajnac. This empirical research was realized through the sample of 118 children divided into four special sub samples – according to gender and time of stay in preschool institutions: sub sample of 26 boys - half day stay, 35 boys - full day stay, sub sample of 23 girls - half day stay and sub sample of 34 girls - full day stay. The evaluation of motor abilities was performed by appliance of six standardized movement tasks. All tests were realized in standard circumstances in the gym. During the testing there was the following table of activities: MPAV – walking along Swedish bench with a turn, for the evaluation of balance, MKLC – rolling of a ball between punts, for the evaluation of coordination with a ball, MSDM – long jump from a standstill, for the evaluation of explosive strength of leg muscles; MBMD – throwing medicine ball, for the evaluation of general arm and shoulder strength; MSPD – long jump bouncing with both legs, for the evaluation of explosive leg strength; and M3x10 – shuttle run 3x10 meters, for the evaluation of speed (Bunčić, 2005). The results of this empirical research were processed by adequate mathematical-empirical procedures. In addition to the procedures of descriptive statistics in order to test the significance of motor ability differences of male and female examinees according to the type of stay the following was applied: multivariant analysis of variance, univariant analysis of variance and discriminative analysis.

## Results

It can be stated that a group of male examinees with full day stay had better results in walking on Swedish bench with a turn (MPAV), in long jump (MSDM), in long jump with bouncing (MSPD) and in shuttle run 3x10 meters (M 3x10). A group of male examinees with a half day stay had better results in rolling of a ball between punts (MKLC) and throwing medicine ball (MBMD). The largest deviation from the mean value, which is described by the values of standard deviation, has the group of examinees with full day stay in variable throwing the medicine ball. Numeric values of coefficient of variation described heterogeneity of the results, in walking along Swedish bench with a turn for both groups of examinees. Homogeneity of the results is the highest in the shuttle run 3x10 meters for both groups. The values of skewness are with negative mark for long jump from the spot, for both groups, which shows extremely positive asymmetric curve. Kurtosis is, for all variables, less than three, which presents that the results are homogeneous and that the curve is leptokurtic. The values of K-S test show that the distribution of values is in the framework of normal distribution for both groups.

Table 1. Central and dispersive parameters and measures of asymmetry and flatness of motor abilities of examinees during half day stay and full day stay

| Variables  | M      | SD    | Error | Min.   | Mah.   | CV    | Int. Sur. |        | Scu.  | Kur. | KS - p |
|------------|--------|-------|-------|--------|--------|-------|-----------|--------|-------|------|--------|
| MRAV - c   | 122.46 | 43.83 | 7.41  | 57.00  | 234.00 | 35.79 | 107.40    | 137.51 | .84   | .21  | .284   |
| MRAV - p   | 146.96 | 45.77 | 8.98  | 82.00  | 254.00 | 31.14 | 128.47    | 165.45 | .45   | -.34 | .213   |
| MKLC - c   | 244.63 | 50.84 | 8.59  | 172.00 | 390.00 | 20.78 | 227.16    | 262.10 | .99   | .83  | .114   |
| MKLC - p   | 238.77 | 34.62 | 6.79  | 179.00 | 327.00 | 14.50 | 224.78    | 252.76 | .43   | .06  | .235   |
| MSDM - c   | 95.71  | 17.93 | 3.03  | 50.00  | 135.00 | 18.73 | 89.55     | 101.88 | -.13  | .25  | .884   |
| MSDM - p   | 82.85  | 23.81 | 4.67  | 42.00  | 112.00 | 28.74 | 73.23     | 92.46  | -1.26 | 1.31 | .477   |
| MBMD - c   | 273.71 | 57.95 | 9.80  | 190.00 | 450.00 | 21.17 | 253.80    | 293.63 | .57   | .48  | .301   |
| MBMD - p   | 295.11 | 43.21 | 8.47  | 215.00 | 420.00 | 14.64 | 277.66    | 312.57 | .56   | 1.11 | .153   |
| MSPD - c   | 52.06  | 9.75  | 1.65  | 36.00  | 79.00  | 18.73 | 48.71     | 55.41  | .87   | .81  | .238   |
| MSPD - p   | 65.04  | 6.11  | 1.20  | 55.00  | 78.00  | 9.40  | 62.57     | 67.51  | .35   | -.56 | .453   |
| M 3x10 - c | 118.57 | 10.44 | 1.76  | 98.00  | 143.00 | 8.81  | 114.98    | 122.16 | .07   | -.46 | .756   |
| M 3x10 - p | 125.58 | 7.59  | 1.49  | 117.00 | 140.00 | 6.04  | 122.51    | 128.64 | .73   | -.94 | .112   |

Table 2. Central and dispersive parameters and measures of asymmetry and flatness of motor abilities of examinees during half day stay and full day stay

| Variables  | M      | SD    | Error | Min.   | Mah.   | CV    | Int. Sur. |        | Skew. | Kur.  | KS - p |
|------------|--------|-------|-------|--------|--------|-------|-----------|--------|-------|-------|--------|
| MRAV - c   | 125.35 | 43.82 | 7.51  | 65.00  | 270.00 | 34.96 | 110.06    | 140.65 | 1.23  | 1.72  | .183   |
| MRAV - p   | 118.00 | 34.49 | 7.19  | 75.00  | 199.00 | 29.22 | 103.08    | 132.92 | .88   | -1.10 | .260   |
| MKLC - c   | 255.44 | 40.58 | 6.96  | 185.00 | 390.00 | 15.89 | 241.28    | 269.61 | 1.07  | 2.10  | .519   |
| MKLC - p   | 269.74 | 47.56 | 9.92  | 180.00 | 385.00 | 17.63 | 249.17    | 290.31 | .92   | 1.08  | .535   |
| MSDM - c   | 86.38  | 17.68 | 3.03  | 51.00  | 119.00 | 20.47 | 80.21     | 92.55  | -.17  | -.76  | .887   |
| MSDM - p   | 69.09  | 14.24 | 2.97  | 40.00  | 90.00  | 20.61 | 62.93     | 75.25  | -.79  | -.40  | .875   |
| MBMD - c   | 245.97 | 58.09 | 9.96  | 60.00  | 360.00 | 23.62 | 225.70    | 266.24 | -.44  | 2.12  | .127   |
| MBMD - p   | 249.57 | 50.07 | 10.44 | 180.00 | 360.00 | 20.06 | 227.91    | 271.22 | .43   | -.64  | .792   |
| MSPD - c   | 52.09  | 10.15 | 1.74  | 36.00  | 87.00  | 19.49 | 48.54     | 55.63  | 1.42  | 2.56  | .123   |
| MSPD - p   | 60.56  | 7.41  | 1.54  | 36.00  | 72.00  | 12.23 | 57.36     | 63.77  | -1.35 | 3.46  | .463   |
| M 3x10 - c | 117.82 | 15.41 | 2.64  | 59.00  | 153.00 | 13.08 | 112.45    | 123.20 | -1.09 | 5.22  | .101   |
| M 3x10 - p | 126.61 | 10.03 | 2.09  | 118.00 | 168.00 | 7.92  | 122.27    | 130.95 | 3.16  | 10.90 | .010   |

For all six variables, by the insight in Table 2, it can be stated that the group of female examinees with a full day stay had better results, in rolling of a ball between punts (MKLC), long jump from the spot (MSDM), and shuttle run 3x10 meters (M 3x10) variables. A group of female examinees with a half day stay had better results in walking along Swedish bench with a turn (MRAV), throwing medicine ball (MBMD), and long jump bouncing with both legs (MSPD). The largest deviation from the mean value, which is presented by the values of standard deviation, demonstrated the group of examinees with a full day stay in throwing of a medicine ball. Numeric values of the variation coefficient showed heterogeneity of the results, in walking along Swedish bench with a turn for both groups of female examinees. Homogeneity of the results is the highest for the shuttle run 3x10 meters for the group with a half day stay. The values of skewness are with negative mark for long jump from the spot for both groups, which shows extremely positive asymmetric curve.

Table 3. Significance of differences between half day stay and full day stay for male and female examinees according to the evaluation of motor abilities

| Analyses           | n | F     | p    |
|--------------------|---|-------|------|
| Manova - 1         | 6 | 8.863 | .000 |
| Manova - 2         | 6 | 9.517 | .000 |
| Discriminative - 1 | 6 | 8.863 | .000 |
| Discriminative - 2 | 6 | 9.517 | .000 |

Kurtosis is higher than three for long jump bouncing with both legs for half day stay group and shuttle run 3x10 meters for both groups, which indicates that the results are heterogeneous and that the curve is platycurtic.

The values of Kolmogorov-Smirnoff test indicate that the distribution of values is in the frame of normal distribution for both groups of female examinees for all six variables. On the basis of the value of multivariate analysis of variance it can be stated that there is statistically significant difference between full day stay group and half day stay group according to all six researched variables with the level of statistical significance  $p=.000$ . Discriminative analysis, as the one of the most precise statistical procedures, also indicates the existence of statistically significant difference and clearly defined line border between half day stay group and full day stay group of male and female examinees in relation to researched variables (Table 3.). By the insight in Table 4, from six variables, by the appliance of univariate analysis of variance, there was a statistically significant difference between two groups of male examinees with different time of stay, in four variables: long jump bouncing with both legs, shuttle run 3x10 meters, long jump from standstill and walking along Swedish bench with a turn. Statistically significant differences are in favour of a full day stay group. The group of examinees with a half day stay had better results in rolling of a ball between punts and throwing medicine ball, but they are not on the level of statistical significance.

Table 4. Differences between full and half day stay of male and female examinees according to evaluation of motor abilities by variables

| ANOVA                                   | F - 1 | p - 1 | F - 2 | p - 2 |
|-----------------------------------------|-------|-------|-------|-------|
| Walking along Swedish bench with a turn | 4.49  | .04   | .46   | .50   |
| Rolling of a ball between punts         | .26   | .61   | 1.48  | .23   |
| Long jump from the spot                 | 5.81  | .02   | 15.27 | .00   |
| Throwing of a medicine ball             | 2.51  | .12   | .06   | .81   |
| Long jump bouncing with both legs       | 35.60 | .00   | 11.77 | .00   |
| Shuttle run 3x10 m                      | 8.39  | .01   | 5.80  | .02   |

Statistically significant difference was found between two groups of female examinees with different time of stay in three variables: long jump from the spot, long jump bouncing with both legs and shuttle run 3x10 meters. Statistically significant differences are in a favour of full day stay group, for long jump and shuttle run 3x10 meters, and for long jump bouncing with both legs is in favour of the half day stay group. The group of female examinees with half day stay had better results in walking on Swedish bench with a turn, (MRV), throwing medicine ball (MBMD), and long jump bouncing with both legs (MSPD) but they are not on the level of statistical significance.

Table 5. Discriminative coefficients between the results of male and female examinees with half day stay and full day stay according to motor abilities

| Variables                            | Discr. coeff. - 1 | Discr. coeff. - 2 |
|--------------------------------------|-------------------|-------------------|
| Long jump bouncing with both legs    | .621              | .346              |
| Shuttle run 3x10 m                   | .166              | .660              |
| Rolling of a ball between punts      | .148              | .002              |
| Long jump from the spot              | .036              | .675              |
| Throwing of a medicine ball          | .032              | .190              |
| Walking on Swedish bench with a turn | .001              | .598              |

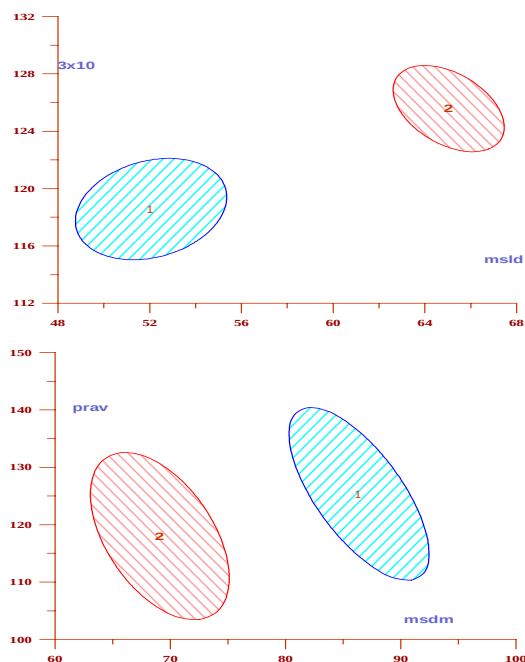
The discriminative coefficients indicate that the biggest contribution to discrimination between different times of stay of examinees according to motor abilities (in fact that the difference is biggest) for long jump bouncing with both legs, with the discriminative coefficient .621, and for female examinees for long jump from the spot with the discriminative coefficient .675. The smallest difference between the two groups of male examinees is found in walking on Swedish bench with a turn with discriminative coefficient .001, and in female examinees in rolling of a ball between punts with discriminative coefficient .002 (Table 5.). 26 male out of 35 male examinees in a full day stay group have defined characteristics, homogeneity is 74.29%, which means that nine examinees have other characteristics and not the characteristics of their group. 23 out of 26 male examinees in a half day stay group have defined characteristics, homogeneity is 88.46% and it is higher. Only three examinees do not have characteristics of their group. 29 out of 34 female examinees in a full day stay group have those characteristics; homogeneity is 85.29%, which means that five examinees have other characteristics from their group.

Table 6. Homogeneity of the results of male and female examinees in half day stay and full day stay according to motor abilities

| Stay          | m/n - 1 | % - 1 | m/n - 2 | % - 2 |
|---------------|---------|-------|---------|-------|
| Full day stay | 26/35   | 74.29 | 29/34   | 85.29 |
| Half day stay | 23/26   | 88.46 | 20/23   | 86.96 |

20 out of 23 female examinees in a half day stay group have defined characteristics, homogeneity is 86.96% and it is higher. Only three female examinees do not have the characteristics of their group (Table 6.).

On the basis of a graph image of ellipsis (interval of trust) it is possible to see position and characteristics of a half day stay group and full day stay group for male examinees according to two most discriminative variables: long jump bouncing with both legs (MSLD) and shuttle run 3x10 meters and for female examinees according to two most discriminative variables: long jump from the spot (MSDM) and walking on Swedish bench with a turn (PRAV). On the Graph 1, for male examinees on abscise (horizontal axis) there are values of long jump bouncing with both legs (MSLD), and on ordinate (vertical axis) there are values of shuttle run 3x10 meters (3x10).



Graph 1. Ellipsis (interval of trust) of motor abilities of male and female examinees according to the most discriminative states.

Full day stay group (1) and half day stay group (2); long jump bouncing with both legs (MSLD) and shuttle run 3x10 meters (3x10); long jump from the spot (MSDM) and walking on Swedish bench with a turn (PRAV).

For female examinees on abscise (horizontal axis) there are values of long jump from a standstill (MSDM) and on ordinate (vertical axis) there are values for walking on Swedish bench with a turn (PRAV). It is possible to notice that according to long jump with bouncing, a full day stay group of male examinees has smaller, and half day stay group of male examinees has higher value of results. In relation to shuttle run 3x10 meters, where a full day stay group of male examinees has smaller values and according to this, better result than a half day stay group of male examinees. For the long jump from the spot, a full day stay group of female examinees has higher, and half day stay group of female examinees has lower value of the results. In relation to walking along Swedish bench with a turn (PRAV) where a half day stay group of female examinees has lower values and as a result better result from a full day group of female examinees.

## Discussion and conclusions

Descriptive indicators indicate approximately better results of male examinees with a full day stay in four out of six variables, and for female examinees in three out of six variables. A half day stay has influenced higher improvement in two variables and for female examinees in three variables. Sabo got similar results (Sabo, 2005) in the research on preschool children who were divided into three groups, depending on time of stay in kindergarten. A group of children that had physical exercises from nursery groups and a group of children that exercised from younger age had statistically significant better motor abilities in eleven out of sixteen variables, compared to a group of children that exercised only eight months before going to school. In their research (Marković, Georgiev & Bogdanović, 2008) they indicate differences between boys and girls of preschool age who are not in anthropometric characteristics on the level of statistical significance, while in three out of six variables there was statistically significant difference in favour of boys. In empirical researches (Madić, 1980; Strel, 1981) they also indicate the existence of differences in physical abilities between genders in favour of boys. From six variables, with univariant analysis of variance, in this research, it was found that there was statistically significant difference between the groups of male examinees with different stay in four variables: long jump with bouncing, shuttle run 3x10 meters, long jump from the spot and walking on Swedish bench with a turn. Statistically significant differences were in favour of male examinees in a full day stay group. A group of female examinees in a full day stay group achieved better results in three out of six variables, but the

values for walking on Swedish bench with a turn are not on the level of statistical significance, which is indicated by univariant analysis of variance. In rolling of a ball between punts, throwing a medicine ball and long jump bouncing with both legs female examinees in a half day stay group had better results, but only the values of long jump with bouncing were on the level of statistical significance. Throwing of medicine ball measures explosive strength where inborn coefficient equals 0.80, it reaches its maximum at the age of 22 and from then on it starts to decline rapidly. Explosive strength is characterized by muscle contraction which is initiated by maximal stimulation of central nervous system, during which maximal number of nerves and muscle nerves is engaged, with the goal of performing motor task (movement of a body in space, and action of a body on object). The test result depends on a motor potential of female examinees, general and special motor education and anthropometric characteristics. If we exclude fluctuations of the results, primarily caused by individual examples, apart from the effects of half day stay and full day stay, we have to consider genetic condition of speed with the coefficient 0.90 and high correlation with strength and flexibility. The speed of performing task is conditioned by previous experience and by the speed of noticing motor problem. Knowing about a high level of innateness, which represents limiting factor for the improvement of the results, interpretation of the results is for both variables performed carefully, without attributing main effect for better results, in this case to full day stay. Improvements of the results in motor abilities are statistically valid prerequisite for a relatively reliable conclusion that a full day stay is educationally more efficient which should be verified with future empirical research.

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## UTJECAJ POLUDNEVNOG I CJELODNEVNOG BORAVKA NA MOTORIČKE SPOSOBNOSTI DJECE PREDŠKOLSKOG UZRASTA

### Sažetak

Cilj istraživanja je bio utvrditi eventualne razlike u motoričkim sposobnostima djece predškolskog uzrasta koje nastaju pod utjecajem efekata dvije različite vremenske i dnevne strukture boravka u predškolskim ustanovama. Istraživanje je transverzalnog karaktera, realizirano u dečjem vrtiću "Dečja radost" u Svilajncu, na uzorku od 118-oro djece podijeljenih u četiri karakteristična subuzorka - prema kriteriju spola i boravka u predškolskim ustanovama i to: subuzorak od 26 ispitanika sa poludnevnom boravkom, 35 ispitanika sa cjelodnevnom boravkom, subuzorak od 23 ispitanice sa poludnevnom boravkom i subuzorak od 34 ispitanice sa cjelodnevnom boravkom. Motoričke sposobnosti procijenjene su sa šest standardiziranih kretnih zadataka. Pored postupaka deskriptivne statistike u obradi podataka dobivenih empirijskim istraživanjem, primjenjena je multivarijantna analiza varijance, univarijantna analiza varijance i diskriminativna analiza. Multivarijantnom i diskriminativnom analizom konstatirana je statistički značajna razlika i jasno definirana granica kod ispitanika i ispitanica poludnevnog i cjelodnevnog boravka, u odnosu na motoričke sposobnosti. Univarijantnom analizom varijance, statistički značajna razlika, između dvije grupe ispitanika, konstatirana je kod četiri od šest varijabli, a kod ispitanica kod dvije od šest istraživanih varijabli. Dobivena poboljšanja rezultata u prostoru motoričkih sposobnosti su statistički validan preduvjet da se o cjelodnevnom boravku, u realizaciji tjelesnog odgoja predškolskog uzrasta, može razmišljati kao o odgojno-obrazovno efikasnijem, što bi trebalo provjeravati budućim empirijskim istraživanjima.

**Ključne riječi:** utjecaj, poludnevni – cjelodnevni boravak, motoričke sposobnosti, predškolski uzrast

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## MODEL FOR ASSESSMENT OF METHODOICAL – PRACTICAL CONTENTS' ACQUISITION OF ATHLETICS TEACHING AT UNIVERSITY

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*Preliminary scientific communication*

### Abstract

*In preparation of normative documents for new standards in our education, special attention is paid to creative activities in the educational process, by both the educator and the student. This new role of the student in the educational process of knowledge creation requires skills and access to teacher-student relationship. By training students at faculties of sport and physical education by the means of athletics disciplines, the appropriate theoretical knowledge and application of practical and methodical content for future teachers of physical education should be ensured. In the effort of theme development the working hypothesis is built on the assumption that the definition of the level of methodical and practical knowledge in athletics lectures will give students objective criteria to control and determine the final mark in this subject. The aim of this paper is to define the classification structure model of methodical-practical knowledge level in athletics lectures. Based on the observations of 135 students of the Faculty of Sport and Physical Education, at the University of Novi Sad, the pedagogical levels are formed and the criteria for adequate assessment of athletics teaching are described.*

**Key words:** athletics, teaching process, methods, structure of levels

### Introduction

Arising socio-economic changes in our society set new demands on the educational system. Approaching Europe, there is the necessity of using new concepts, contents and the selection of new curricula. In this regard, the authorities took the position regarding the management of educational processes at different stages of education. In preparation of normative documents for new standards in our education, special attention is paid to creative activities in the educational process, by both the educator and the student (8, 11). This new role of the student in the educational process of knowledge creation requires skills and access to teacher-student relationship (1, 4, 10, 13). Another important change is delimitation and changing from previous reproductive knowledge and education of students to the ability of self-informing and self-control. Applied to the teaching process, that is achieved through specific pedagogical and didactic criteria that are directed to the establishment of improvement in the teaching process (2, 6, 7). Logically, it follows that the analysed changes require the actualising of curricula and preparation methods of future pedagogues and teachers of physical education (5, 9, 12, 14). By training students at faculties of sport and physical education by the means of athletics disciplines, the appropriate theoretical knowledge and application of practical and methodical content for future teachers of physical education should be ensured (3). Future teachers' education has two stages (15): firstly, the adoption of athletics disciplines' techniques, and mastering methodical and practical skills used for the teaching of athletics disciplines in school physical education, at the second stage.

### The aim and objectives

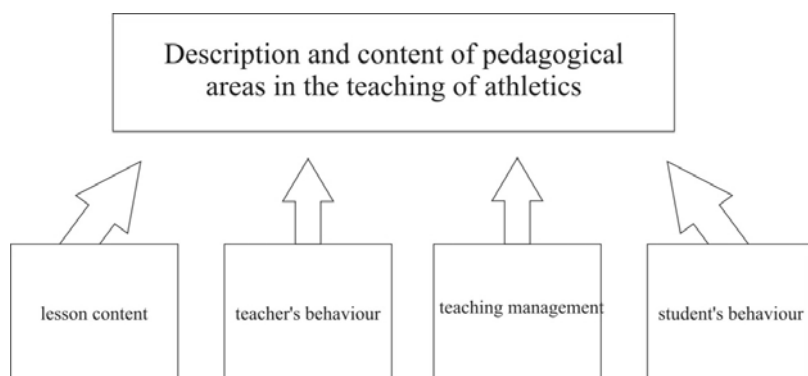
In the effort of theme development the working hypothesis is built on the assumption that the definition of the level of methodical and practical knowledge in athletics lectures will give students objective criteria to control and determine the final mark in this subject. The aim of this paper is to define the classification structure model of methodical-practical knowledge level in athletics lectures.

To achieve this target the following tasks are set:

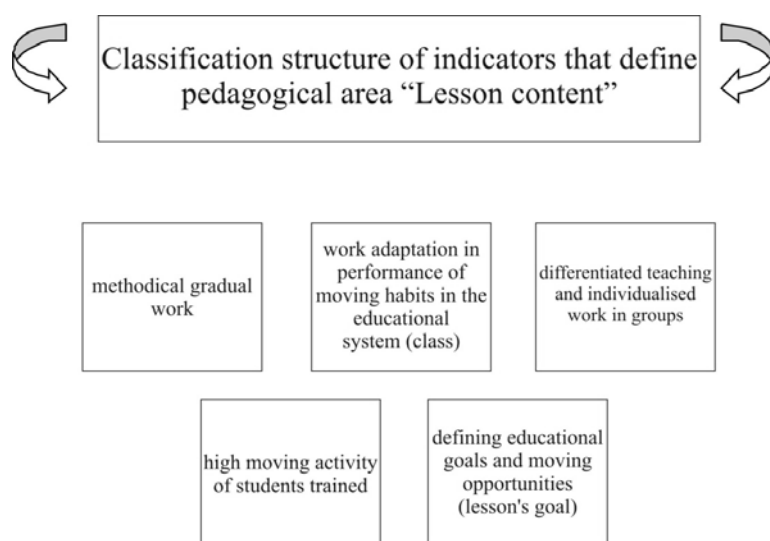
1. Setting of problems supported by literary data obtained from the appropriate sources.
2. Systematization and defining of pedagogical areas.
3. Horizontal hierarchy for pedagogical areas determination by the structural level of teaching
4. Selection and defining of the exact criteria applied and vertical hierarchy of pedagogical areas.
5. Classification structure of methodical-practical knowledge of athletics teaching.

The subject of this paper is based on the area of pedagogical activity as a set of criteria for determining the level of methodical-practical knowledge in athletics lectures. The research is based on: 1) Theoretical indicators, to determine the pedagogical areas and criteria for their definition, and 2) Practical indicators, obtained by observing 135 second year students of the Faculty of Sport and Physical Education, at the University of Novi Sad, who were involved in the teaching of athletics.

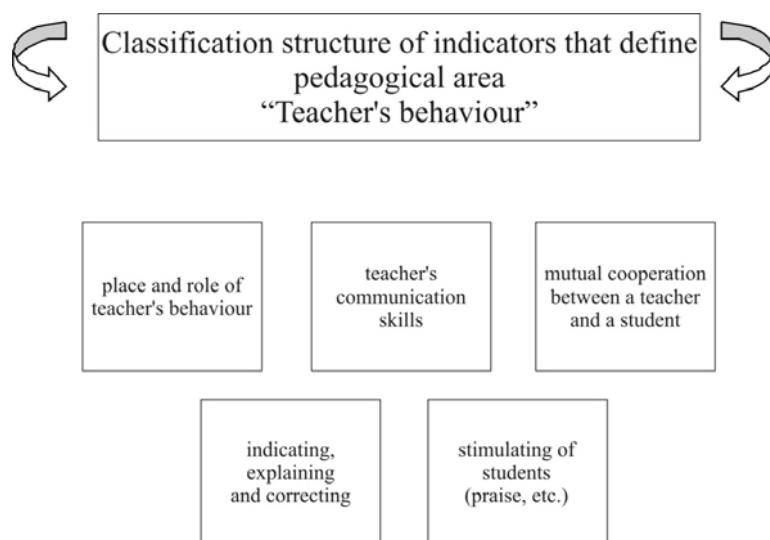
## Structures



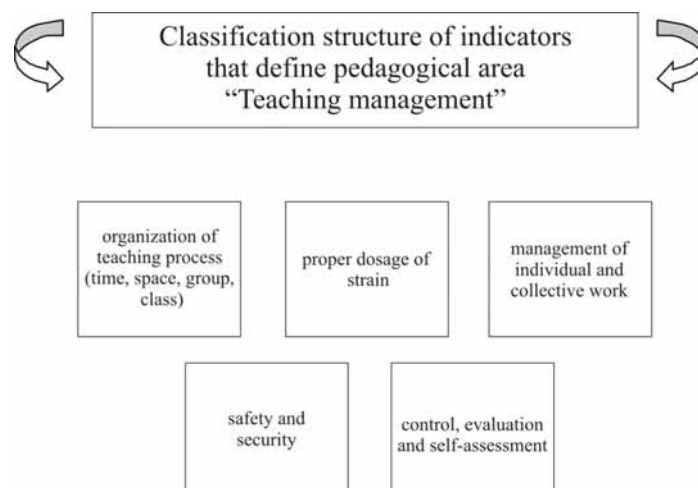
Scheme 1: Description and content of pedagogical areas in the teaching of athletics



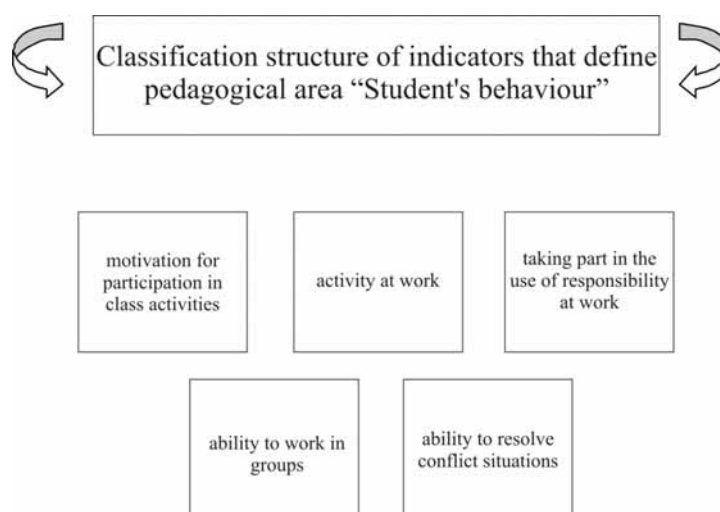
Scheme 2: Pedagogical area "Lesson content"



Scheme 3: Pedagogical area "Teacher's behaviour"



Scheme 4: Pedagogical area "Teaching management"



Scheme 5: Pedagogical area "Students' behaviour"

Table 1: Standards for the assessment of methodical - practical knowledge level of athletics teaching

| levels                     | Lesson content                                                                                                                      | Teacher's behaviour                                                                                                                      | Teaching management                                                                                                          | Student's behaviour                                                                                                          |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| First level: weak          | missing methodical and systematic differentiation in groups, adaptation of moving habits according to education level               | missing obedience in class, discipline, attention, bad spoken communication between teachers and students                                | missing organization, waste of spatial facilities, lesson duration imbalance, bad strain dosing                              | weak moving activity, lack of motivation, inattention during the execution of tasks, does not want to work in a group        |
| Second level: satisfactory | does not follow the concept of lesson, imprecise training target, poorly defined moving tasks for the appropriate educational level | poor student-teacher cooperation, difficulties in selecting assets and demonstrations                                                    | management present, but there is a lack of precise dosage and duration of different parts of lessons                         | random and spontaneous motivation only in some activities, bad group work and participation in tasks solving                 |
| Third level: good          | difficulties in methodical order and the differentiation of group work, but the internal conception of lessons preserved            | mild occurrence of pedagogical relation to inclusion in moving activity, lacking feedback, and the variability of means of communication | periodic difficulties in management, but often improved through concrete indications of dosage and criteria for control      | different presence of motivation in moving tasks performance, but visible positive tendency                                  |
| Forth level: very good     | properly formulated objectives, methodical sequence, adapted work, good concentration, working with clearly differentiated groups   | teacher-student relationship established, proper positioning of the department, appropriate communication                                | systematisation and mastering the elements of class management: optimal dosing, organization and proper criteria for control | great interest in teaching content and activities, motivation, mutual respect and support, resolving conflicts, self-control |

Scientific analysis is based on several experiences from previous practice and it allows us to concretize the four areas of pedagogical activity. They include the basic teaching process with particular attention to teacher-student relationship. Facing the European trends in teaching, in physical education teaching as well, and discovering new demands of state standards in the general education system, we suggest the following definition of certain pedagogical areas.

Criteria for the recognition of teachers' abilities during the lesson:

- teachers' lessons are interesting and dynamic,
- there is a high moving activity of students in lessons,
- motivation of student for participation in the work,
- provoking good behaviour and positive impact on students,
- encouraging creativity,
- using students' participation in the final self-evaluation,
- positioning and meeting the individual development of students,
- encouraging specific success detection in pedagogical process,
- forming students' ability to use individual and collective responsibility.

Criteria for teacher's behaviour:

- Stimulating students to work- challenging students' positive thinking and action,
- having accurate, clear and concrete indications of errors,
- motivating students in all activities.

Criteria for the recognition of teachers' skills in teaching management:

- appropriate using, if necessary, prolonging or shortening of the length of lessons and parts of lessons,
- making the most of existing space for exercise,
- using various forms of organization in lessons,
- knowledge of how to properly arrange students in groups within a department according to their abilities,
- individualising the extent of strain in a given group,
- accurate determining in the process of training,
- ensuring the safety and security of children during exercise

Criteria for the observation of teachers' behaviour in managing students' behaviour:

- establishing knowledge, skills and attitude at work,
- proposing situations for the implementation of individual and collective solution,
- creating skills for spotting rules of conduct,
- motivation achievement through the creation of knowledge

and self-management, - creation of knowledge and skills for safe operation and assistance.

Based on the analysis of the proposed pedagogical areas and criteria for implementation and creative interpretation of the curriculum, four levels of methodological and practical knowledge can be established in athletics lectures (Table 1): the first level is the weakest, and the fourth is the best. The level order is determined by teacher's ability (teacher-to-be). Every teacher has to overcome the difficulties and problems that are described in four educational areas and to adapt to the criteria exposed by process management of athletics lectures. The criteria for each pedagogical area are given vertically and separately for each level.

Criteria for methodical - practical knowledge assessment for integral teaching in all four areas are presented horizontally. In conclusion, we can say that the proposed criteria from pedagogical areas make methodical and practical knowledge assessment objective in athletics lectures in the school system. In the teaching practice of students who are involved in athletics teaching at the Faculty of Sport and Physical Education, at the University of Novi Sad, the scoring in relation to the above four levels proposed in the table is used, optimised by adding other points won in other activities. This allows the assessment of methodical-practical knowledge in lectures after a six-grade scale.

## Conclusion

Based on the observations of 135 students of the Faculty of Sport and Physical Education, at the University of Novi Sad, the pedagogical levels are formed and the criteria for adequate assessment of athletics teaching are described. Thus, such an analysis allows the formulation of the following conclusions: 1. we systematized and defined four areas of pedagogical work in athletics lectures 2. we exactly specified measurable criteria for pedagogical areas, 3. we set horizontal and vertical architecture on the structural level of lectures after pedagogical areas, 4. classification structure of methodical-practical knowledge in athletics lectures, 5. normative tables for criterion assessment on a six-grade scale were obtained. This is one of the attempts to improve the teaching process, which refers to teaching after specific pedagogical and didactic criteria that are directed towards the establishment of improvement in the teaching process (2, 6, 7).

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## MODEL ZA PROCJENU USVOJENOSTI METODIČKO-PRAKTIČNIH SADRŽAJA NASTAVE ATLETIKE NA FAKULTETU

### Sažetak

U pripremi normativnih dokumenata za nove standard u edukaciji, posebna pozornost se poklanja kreativnim djelovanjima u edukacijskom procesu, i od strane edukatora a i učenika. Ova nova uloga učenika u edukacijskom procesu kreacije znanja zahtijeva vještine i pristup relaciji učitelj-učenik. U pripremi studenata na fakultetu sporta i tjelesnog odgoja uz pomoć atletskih sadržaja, moraju biti osigurani odgovarajuće teorijsko znanje i primjena praktičnog i metodičkog sadržaja budućih učitelja tjelesnog odgoja. U nastojanjima razvoja promišljanja, realno je za pretpostaviti da definicije razine metodičko-praktičnih znanja iz atletike mogu dati učenicima objektivne kriterije kontrole i određenja finalne točke u ovoj temi. Cilj ovog članka je definicija klasifikacije strukturnog modela razine metodičko-praktičnih znanja nastave atletike. Na temelju praćenja 135 studenata Fakulteta sporta i tjelesnog odgoja Univerziteta u Novom Sadu, formirane su pedagoške razine i opisani kriteriji za odgovarajući pristup vrednovanju nastave atletike.

**Cljučne riječi:** atletika, nastava, metode, struktura razina

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## THE UNIVERSAL METHODOLOGY OF PROCESS IDENTIFICATION

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*Original scientific paper*

### Abstract

*By means of the model of simulating the development of pseudo-objects in a finite space the sub-segments of the totally defined process were successfully recognized and described. These sub-segments show the domination in comparison to other sub-processes in particular periods. On the basis of the positions of certain sub-segments, but also on the basis of their interactions, the bearers of the pieces of information that designate the process were identified and in terms of parameters determined as: Communicativeness, Expansion, Level of Organization, Coherence, Stableness and Harmony. By means of the algorithm that places the polar taxons cumulatively into the 'Indifg' position, the completely consistent and uninterrupted series of related points were obtained that described important phases of each process: 1) release of initial energy, 2) variations induced by energy, 3) collection and amassment of materials, 4) cognition or learning, 5) external integration of resources and 6) preparation for the transfer into a new process or to a new level. This paper offers the regularities, that is, the universal parameters and phases of a process that are transparent and easily applicable in many situations and in any field.*

**Keywords:** process, identification, taxons, time, development

### Introduction

In the broadest sense, processes imply the events, regardless of the ways in which they are defined, connected with some objects or entities within a time interval set in a particular way. This implicitly means that there will be no process if there are no visible changes on objects monitored throughout a particular transformation. This is the reason why some previously set parameters – the variables by means of which these objects are measured – are used to describe and to monitor the transformation of objects. Under the classical cybernetics definitions, we are talking about compound of methods that guide us to some type of status definition and regulation, as shown by Andrews (2002), Novaković (1990), and Gordon (1978). Considering those methodological principles the existence of entire group of procedures for system analysis and system identification with final aim is evident, when processes are primarily too complex or stochastic to process analysis. Some basic examples are presented in works of Bartolomew (1973), Bartlett (1978), Campbell (1958), and Kecman (1990). In the same wide sense, a measurement implies any operation that, in congruence with a complete and accurate set of rules, makes it possible to describe a sign or a number that relates to a particular characteristic to an object which is a member of a homogeneous set of objects, so that any two objects that differ in this characteristic may be differentiated from one another according to this characteristic, and that any two objects that are identical according to this characteristic may be considered to be identical. Owing to methodology and computer development, it is possible to create projects with multivariate methods that include a large number of parameters to control events or processes as shown by Ogata (1967), Šurina (1991) and Astrom (1989).

Thus, the set of values of some variables designating a set of objects is defined. If these variables are applied in two or more consecutive time points, then it is possible to compare the data between such two points. If the results in these two points display the differences that are not the result of measurement errors, it may be correctly said that a process in the interval between the two time points affected the objects and induced the changes registered by a measurement. That was presented by Bonacin (2002), Hotelling (1933), Jardine & Sibson (1971), Momirović at al. (1987), Ristanović at al. (1986), Rosenbrock (1967) and Zadeh & Desoer (1963). By reasonably assuming that generally at least one permanent system of events may affect the objects, and consequently the results displayed as differences, the issue of defining the process is decomposition of a composite process in its parts that can be described in a particular phases as presented by Bonacin & Carev (2002) or Momirović at al. (1987). Likewise, by assuming these systems are generally of events, the elements of the composite need does not contain the phases that overlap in time, the issue of process identification apparently comes down to determining the existence, intensity, onset, duration and completion of a particular part of the sub-segmented process as shown by Bonacin & Carev (2002). Assuming that it is possible to collect the multivariate data in the space that extends over some variables and that it is possible to monitor the objects whose transformations we are interested in, through numerous consecutive time points, then the identification of any processes comes down to detecting those sub-processes that commence their dominant agency in one of these n time points which is methodologically proved by Bonacin & Carev (2002) or Momirović at al. (1987).

Likewise, in some particular point the agency of a sub-process decreases and creases to be dominant for the entire process, thus making way for another sub-process to begin. Process identification is simply the detection of the position of the time point within the total number of points when a sub-process becomes dominant. Many processes are too complex, and seemingly rarely allow too large a number of time points through which the performance of a set of objects is followed. However, all processes characterized by a set of acquired parameter values allow such an approach. Lately, the number of such processes in many scientific areas is increasingly high, for example, computer simulations, in medicine and diagnostics when entities are continuously engaged in the analyses of processes on specialized devices such as monitors or treadmills implying the analysis of ventilation-related issues, in real-time process monitoring, in tele-controlled analysis, in data analysis on the basis of different video and stimulation devices, etc. It is, therefore, possible to define such algorithms and such models of data synthesis that provide reliable process identification in technical sciences, but also elsewhere as shown by Bonacin & Carev (2002).

## Materials and Methods

To illustrate the identification process for the purpose of this paper, the data about the development model of pseudo-objects in a finite two-dimensional space ranging from a completely empty space to the complex phenomena occurring in it were mostly generated and simulated on a computer. First of all, it was 9x9 area defined as a space where everything occurs (there were several different models, e.g. 7x7, 8x8, 10x10..., and all of them derivate same results). The simplest entity was white, empty surface of 9x9 points, explaining that there was nothing. Then the authors generate few hundred entities, and the computer, using random generator function, generates more entities in that space, with different structure, from simplest point to more complex figures. Finally, the computer made a semi-random choice and chooses final 700 objects from that bulk. This number of 700 entities was not chosen randomly, because that number allows any correlation, factor or taxon saturation etc. that is larger than 0.10 to be significant at probability level of 0.01. It was done several times with randomly chosen different sets of 700 entities, and the results were always the same. Acquisitioned collection of data for 700 entities was simulated and monitored with a larger number of variables that was eventually reduced to 14 acquisitioned variables and 4 arbitrary variables. This reduction was made by classical factor model with oblique rotations defined by Momirović at al. (1987) and programmed by Bonacin (2002), so only variables with significant saturations of any factor were included in further model. Those 14 variables were: number of points for information receiving (BRPR), number of points which cannot receive direct information from outside area restricted by skeleton (XXXX), number of points in

skeleton (BRSK), total number of points (BRT0), most distance free extern point (NSET), most distance free point in general (NSTO), maximal number of steps for information transmitting in the worst case (IMXV), minimal number of steps for information transmitting in the best case (IMNV), number of points for information emission (BREM), number of connections (BRSP), total number of lines (BRLU), number of points in "prison" (BRVR), total number of direct relations between points (BREL) and total number of free points rounded (ZAPO).

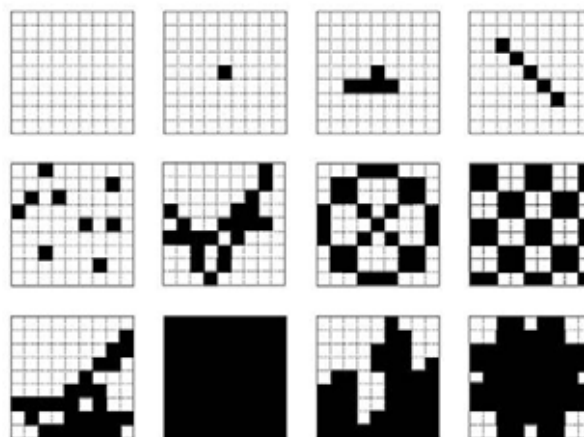


Figure 1. Some examples of primary entities

Arbitrary 4 variables were: simplicity (JEDS), reproducibility (REPR), regularity (PRAV) and symmetry (SIME). Each of those four arbitrary variables were estimated by 3 independent judges, and final estimate result was generated by their common measure, by projecting their estimates on the first factor as common measuring subject generated by factor analysis of principal components founded by Hotelling (1933) and programmed by Bonacin (2002). It is very interested that several variables showed distribution that is different than normal, but all mechanisms of higher level (taxons) show absolute normal distribution. That fact was established by standard Kolmogorov-Smirnov testing like Momirović (1987) proposed and programmed by Bonacin (2002). To achieve an accurate identification, these 18 variable data were taxonomized according to the Momirović's (1987) model of polar taxons until the general and ultimate taxon was derived. The procedure first generates 6, then 3 taxons of higher level, then two. Finally it was one global taxon derived. Taxonomic procedure was chosen because it most efficiently describes the objects (entities), and if we want to understand processes it is obviously that we have to maintain the transformation of our data in object's space, not in the space of variables which is frequently the case.

### Polar taxons algorithm

Let the  $\mathbf{Z} = (z_{ij})$ ;  $i=1, \dots, n$ ;  $j=1, \dots, m$  is standardized matrix of collected data with description of some set of entities  $\mathbf{E} = \{e_i$ ;  $i=1, \dots, n\}$  with some variable set  $\mathbf{V} = \{v_j$ ;  $j=1, \dots, m\}$ .

Let the  $\mathbf{R} = \mathbf{1}/n \mathbf{Z}^T \mathbf{Z}$  is variable correlation matrix. Structure definition of matrix  $\mathbf{R}$  is

$$\mathbf{R} = \sum_{p=1}^q \lambda_p \mathbf{x}_p \mathbf{x}_p^T + \sum_{p=q+1}^m \lambda_p \mathbf{x}_p \mathbf{x}_p^T$$

where  $q = \text{num}(\lambda_p \geq 1.0)$ , and where  $\lambda_p$ ;  $p=1, \dots, m$  are eigen values of matrix  $\mathbf{R}$ , and  $\mathbf{x}$  are eigen vectors of matrix  $\mathbf{R}$  normalised to satisfaction

$$\mathbf{x}_p^T \mathbf{x}_p = 1 \quad \forall p, \quad p=1, \dots, m$$

First we organise the first  $q$  eigen values  $\lambda_p$  in diagonal matrix  $\mathbf{L} = (\lambda_p)$  and the first  $q$  eigen vectors in matrix  $\mathbf{X} = (\mathbf{x}_p)$ . Un-standardized principal components derived from data matrix  $\mathbf{Z}$  will be vectors  $\mathbf{K} = \mathbf{Z} \mathbf{X}$ . Then we apply polar taxons algorithm with  $\mathbf{T}$  orthonormal matrix defined as

$$\mathbf{G} = (\mathbf{g}_p) = \mathbf{K} \mathbf{T} \quad \left| \quad n \sum_{i=1}^n \sum_{p=1}^q g_{ip}^4 - \sum_{p=1}^q \left( \sum_{i=1}^n g_{ip}^2 \right)^2 = \max \right. \\ \left. \mathbf{T}^T \mathbf{T} = \mathbf{I} \right.$$

in order to maximise Kaiser Varimax function.

Covariances of taxonomic dimensions derived by these transformations are elements of matrix;

$$\mathbf{C} = \mathbf{G}^T \mathbf{G} / n = \mathbf{T}^T \mathbf{L} \mathbf{T}.$$

If  $\mathbf{D} = \text{diag}(\mathbf{C})$

is one diagonal matrix of taxonomic dimensions variances, correlations of taxonomic dimensions will be

$$\mathbf{M} = \mathbf{D}^{-1} \mathbf{C} \mathbf{D}^{-1}.$$

We standardize taxonomic variables with operation

$$\mathbf{L} = \mathbf{G} \mathbf{D}^{-1}.$$

Structure of taxonomic dimensions will be in matrix

$$\mathbf{F} = \mathbf{Z}^T \mathbf{L} / n = \mathbf{X} \mathbf{L} \mathbf{T} \mathbf{D}^{-1},$$

and their coordinates in oblique space defined with taxonomic vectors will be columns of matrix

$$\mathbf{A} = \mathbf{F} \mathbf{M}^{-1} = \mathbf{X} \mathbf{T} \mathbf{D}.$$

Obviously, if initial objects data described by 18 variables indicates the simplest space representation, then the general and ultimate taxon represents the final solution in the defined space. It is clear by intuition, and is easy to prove that the final solution is something to which our objects (entities) are converging in defined space, according with their characteristics described with variables of lower level. Owing to large number of entities, it is easy to prove that global representation is ensured and that it is almost irrelevant if there were 700 or 7000 entities, which is firmly verified by Central Limit Theorem.

Model of polar taxons produces one bipolar characteristic for each taxon so the recognition of those characteristics is connected with: a) recognition of variables which define taxons in variable space (Table 1.), and b) recognition of typical entities with maximal projections on extreme sides of taxon (Figure 2.). Consequently, six easily interpretable taxons were obtained: 1. communicativeness (+ passivity, - activity), 2. expansion (+ material, - spatial), 3. level of organization (+ complexity, - simplicity), 4. coherence (+ dispersion, - compactness), 5. stableness (+ stability, - variability) and 6. harmony (+ order, - chaos).

Table 1. Oblique position of taxonomic dimensions (matrix  $\mathbf{A} = \mathbf{F} \mathbf{M}^{-1}$ )

|      | Tax1         | Tax2        | Tax3        | Tax4        | Tax5         | Tax6  |
|------|--------------|-------------|-------------|-------------|--------------|-------|
| BRPR | <b>0.53</b>  | 0.12        | 0.44        | 0.09        | 0.33         | -0.38 |
| XXXX | <b>0.49</b>  | 0.40        | -0.42       | -0.26       | -0.22        | 0.12  |
| BRSK | <b>0.72</b>  | 0.30        | -0.15       | 0.13        | -0.05        | 0.01  |
| BRTO | <b>0.66</b>  | 0.41        | -0.08       | -0.10       | 0.30         | 0.11  |
| JEDS | <b>-0.93</b> | 0.35        | 0.05        | 0.06        | 0.04         | 0.15  |
| REPR | <b>-0.89</b> | 0.48        | 0.10        | 0.04        | -0.04        | 0.11  |
| NSET | <b>-0.57</b> | -0.56       | -0.09       | 0.08        | 0.27         | 0.30  |
| NSTO | <b>-0.60</b> | -0.52       | -0.13       | 0.06        | 0.19         | 0.38  |
| PRAV | -0.68        | <b>0.83</b> | 0.09        | 0.21        | -0.07        | -0.04 |
| SIME | -0.47        | <b>0.89</b> | 0.12        | 0.28        | 0.00         | -0.10 |
| IMXV | 0.36         | 0.04        | <b>0.84</b> | -0.11       | -0.19        | 0.39  |
| IMNV | 0.35         | 0.16        | <b>0.71</b> | -0.16       | -0.30        | 0.48  |
| BREM | -0.03        | -0.26       | <b>0.68</b> | 0.12        | 0.12         | -0.44 |
| BRSP | 0.46         | -0.01       | -0.13       | <b>0.75</b> | 0.09         | 0.23  |
| BRLU | 0.51         | 0.00        | -0.06       | <b>0.77</b> | 0.05         | 0.18  |
| BRVR | 0.12         | 0.38        | -0.03       | -0.40       | <b>0.74</b>  | 0.15  |
| BREL | 0.46         | 0.39        | -0.16       | -0.13       | <b>0.55</b>  | 0.17  |
| ZAPO | 0.30         | 0.19        | -0.31       | -0.14       | <b>-0.80</b> | 0.01  |

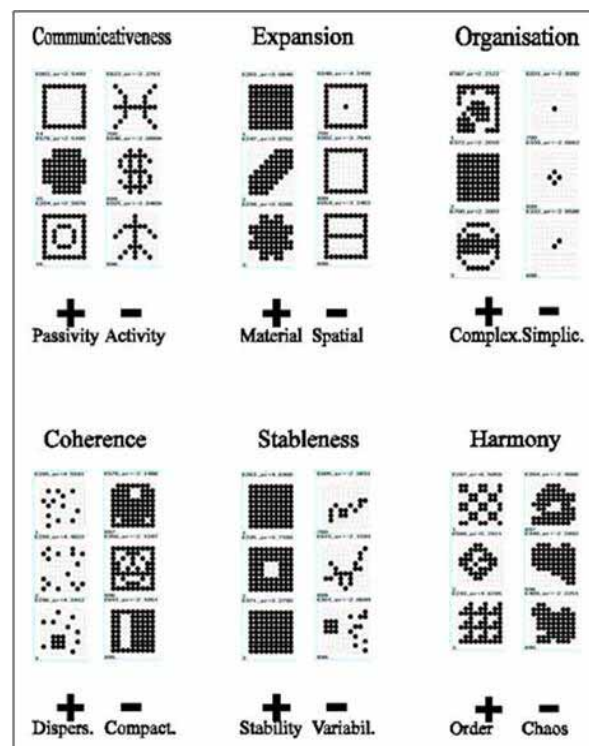


Figure 2. Typical entities with maximal projections on extreme sides of taxons (plus (+) and minus (-) signs represents the extreme characteristics of each taxon)

In that moment, the "time continuum" was defined by sorted taxonomic data according with general taxon, although the authors rather call it "development continuum" because of the higher position of entity which this taxon represents; higher level of development. Although that continuum implies 700 points these 6 taxons were monitored for the purpose of an easier identification of sub-processes, that is, through a set of time points dominated by a particular sub-process.

The results achieved by the objects in taxons obtained in this way were put into a system of cumulative data ranging from the simplest-initial (1) to the complex final point (700), simulating development of one object through 700 equidistant time points. The Indifg algorithm made by Momirović at al. (1987) was subsequently applied to analyse the data that were organised in this way. This algorithm decomposes the matrix of data into the left and right eigenvectors in order to identify related time points.

#### Indifg algorithm

Assuming that  $V = \{v_j ; j = 1, \dots, m\}$  is a set of quantitative variables, and  $T = \{t_i ; i = 1, \dots, n\}$  is a set of equidistant ordered time points, and  $e$  is an investigation object from some population  $P$ . Operation  $P^* \leftarrow T \otimes V$  is forming a matrix  $P^* = (p^*_{ij}) ; i=1, \dots, n ; j=1, \dots, m$  as changes trajectories matrix of  $m$  variables at  $n$  time points connected with investigation object  $e$ . Let  $\mu = (\mu_{ij}) ; i = 1 ; j = 1, \dots, m$  is a result of  $m$  variables in the first time point (first row of matrix  $P^*$ ), and  $\phi = (\phi_{ij}) ; i = 1, \dots, n, \phi_i = 1.0$  summ vector of  $n$  elements. Operation  $P = P^* - \phi \mu^T$  is centering whole data matrix on the first time point value. By spectral decomposition of matrix

$$P = \sum_{j=1}^m Y_q X_q^T$$

there are defined the changes trajectories generators. Those generators could be reduced to appropriate number by some criterion: a)  $k =$  number defined in advance, b)  $k = m$  (total number of variables, taxons, factors or similar initial data), c)  $k = \text{num}(\delta\theta \leq \sum \delta\theta^1/m)$ . Let we form  $\Delta = (\delta q)$  diagonal first  $k$  eigenvalues matrix with  $\delta q \geq \delta q+1$ , and matrix  $Y = (y q)$  with first  $k$  left eigenvectors of data matrix  $P$ , as well as matrix  $X = (x q)$  with first  $k$  right eigenvectors of data matrix  $P$ . Parsimony transformation left eigenvectors of data matrix is performing because of detection of related time points by keeping the system of generators in orthogonal position. That was done by satisfying Kaiser Varimax function

$$T=(tp)=Y W$$

$$n \sum_{i=1}^n \sum_{q=1}^k t_i^4 - \sum_{q=1}^k \left( \sum_{i=1}^n t_i^2 \right)^2 = \max$$

$$W W^T = W^T W = I$$

Matrix  $T$  represents taxons of time-point set, and in the  $W$  matrix there are cosines of directional time-taxonomic vectors in order with left vectors of trajectories matrix. By orthonormal transformation of right eigenvectors of data matrix there are defined the taxons of variables with varimax function maximization, and with a condition that this system is orthogonal to

$$F=(fp)=Q$$

$$n \sum_{i=1}^n \sum_{q=1}^k f_i^4 - \sum_{q=1}^k \left( \sum_{i=1}^n f_i^2 \right)^2 = \max$$

$$Q Q^T = Q^T Q = I$$

Matrix  $F$  contains coordinates in orthogonal time taxonomic system, and the  $Q$  matrix contains angle cosines between right vectors of trajectories matrix and vectors that defines sets of time points.

The data for each such taxon, as well as for all taxons together were graphically presented. Smoothed representation line was generated by 5<sup>th</sup> order polynomial trend-line, although 4<sup>th</sup> order trend-line generates almost identical results. All methods were generated from algorithms and methods for multivariate data analysis and data signal processing proposed in segments by Bonacin (2002), Bonacin & Carev (2002), Carev (2000), Chabert at al. (2000), Chung (2002), Jardine & Sibson (1971), Karaman & Momirović (1984), Middleton & Goodwin (1990), Momirović at al. (1987), Monroe (1962)...

#### Results and Discussion

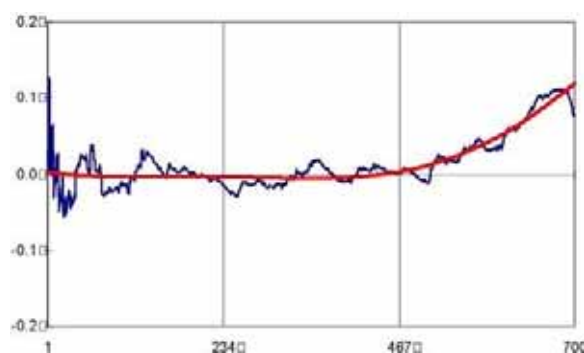


Figure 3. Communicativeness (+ = passivity)

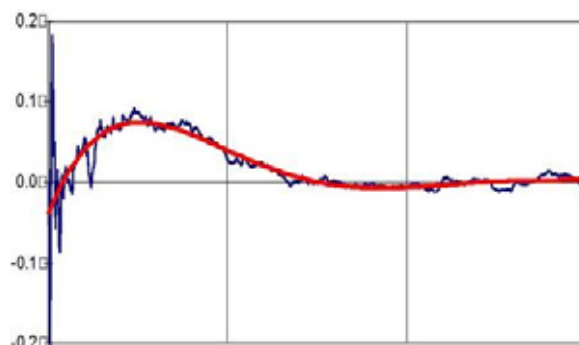


Figure 4. Expansion (+ = material expansion)

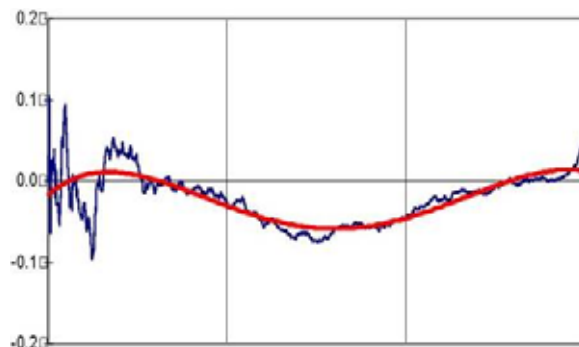


Figure 5. Level of organization (+ = complexity)

The data analysed in the way described previously were translated into trajectories for each of the six sub-processes.

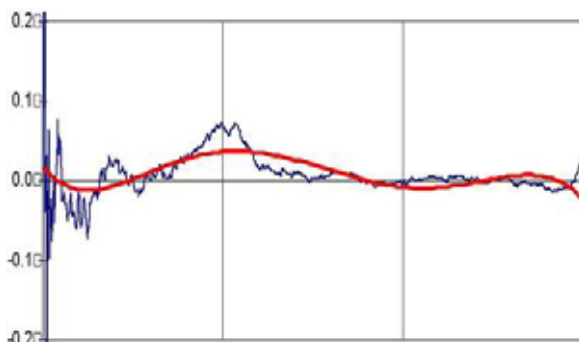


Figure 6. Coherence (+ = dispersion)

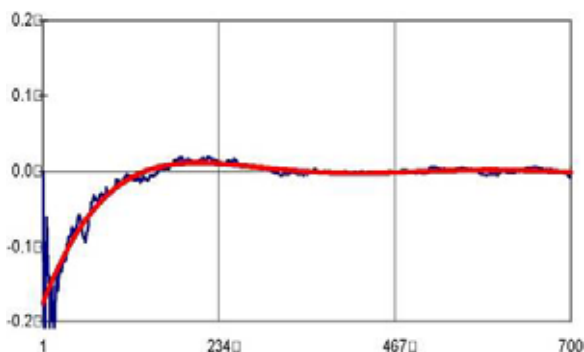


Figure 7. Stableness (+ = stability)

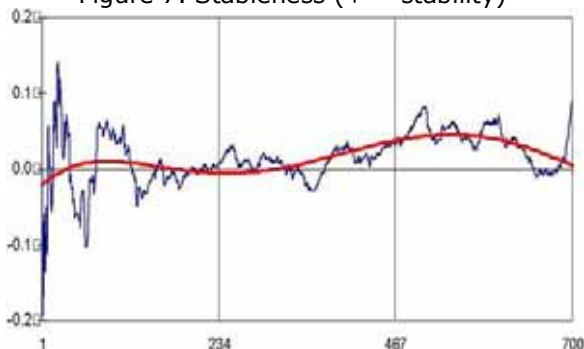


Figure 8. Harmony (+ = order)

The presented Figures displays the indicators of increment in each individual sub-process, that is, in the effects that comprise the total analyzed process. Apparently, these six impacts (agencies) show the shapes of time distribution precisely in the way that suggests the domination of one out of the six agencies in a particular period.

At the beginning, it is evidently instability that is dominant, which is understandable because at the beginning of each process there are numerous reasons that lead to this instability. In the end, when the total process is stilled significant passivity is expressed, because the process itself went through all previous phases. These are definitely the two basic sub-processes that indirectly describe the commencement and the completion of a process. It is obvious that stabilization occurs after approximately 1/3 of the process (approximately at the point 234). Expansion may also be recognized within ultimate limits of the process, namely, in the first and in the second part of the process, although right out dominantly after the beginning. Simultaneously, the increase in the level of organization is mostly negative, which means that the structure of the entire process is mostly simple.

Simplicity turns into complexity at the end of the process. Stableness virtually acts according to the logarithmic function, but also according to the function that describes the object that was thrown off balance and that redresses this balance slowly. Harmony behaves in the same way, but formally near process finalization. Namely, immediately after the beginning of the process it takes the form of the chaos, but it stabilizes already from the middle of the process onwards. Finally, coherence (dispersion) is directly in congruence with the second (longer) phase of the total process. It is easy to recognize the initial phases of the process in which the *initial uncontrolled release of energy* of the process itself is reflected, approximately up to the point 10-12 (approx. 1.5% of the total), which is particularly noticeable in Figures 3-8. This describes the regularities of the initial impetus of the process. Somewhere around the point No. 110 (approx. 15.0% of the total) the chaos of the process is somewhat more expressed due to the *variations* that occur between the point's No. 10 and 110. Simultaneously, instability disappears and after about one third of the process the *amassing of materials (or perceptions)* is dominant and it is reflected as dispersion of the available material.

This is the reason why the level of organization decreases significantly and will continue to decrease up to approximately 50% of the total duration of the process when the expressed increase of sources amassment is completed, and further arrangement in terms of complexity may proceed. Entirely, the listed issues describe the cognition or *learning* that is particularly accelerated towards the end of the process. Approximately at the half of the total process, expansion develops, that is, the *external expansion* of additional resources. Finally, the model becomes passive because it integrated everything that could be integrated so that it reaches the limits of the space and actually executes the *preparations for opening a new space*. These phases are very similar to the general phases of any process. As we can see, all these or similar parameters are sometimes partially mentioned in several publications, egg., Akgunduz at al. (2002), Aneiros-Perez & Quintela-del-Rio (2002), Athans at al. (1974), Berlinet & Biau (2000), Chabert at al. (2000), Chen & Desoer (1967), Chung & Dey (2002), Fang (2001), Hirshman at al. (2002), Ikram & Zhou (2001), Liptser & Spokoiny (2000), Nandini & Debasis (2001), Rosenbrock (1967), ... , but there is no system or coherent model that founded global parameters of process identification. That is what we present in this paper.

## Conclusion

By the means of the model of simulating the development of pseudo-objects in a final space the sub-segments of the totally defined process were successfully recognized and described. These sub-segments show the domination in comparison to other sub-processes in particular development periods.

On the basis of the positions of certain sub-segments, but also on the basis of their interactions, the bearers of the pieces of information that designate the process were identified and in terms of parameters determined as: Communicativeness, Expansion, Level of Organization, Coherence, Stableness and Harmony. By means of the algorithm that places the polar taxons cumulatively into the Indifg position, the completely consistent and uninterrupted series of related points were obtained that described important phases of each process: 1) release of

initial energy, 2) variations induced by energy, 3) collection and amassment of materials, 4) cognition or learning, 5) external integration of resources and 6) preparation for the transfer into a new process or to a new level. It may be concluded that all mentioned here, are the regularities, that is, the universal parameters and phases of a process that are transparent and easily applicable in many situations, and more attention should be paid to these issues regarding their essentials but also their utilization for the purpose of research in any field.

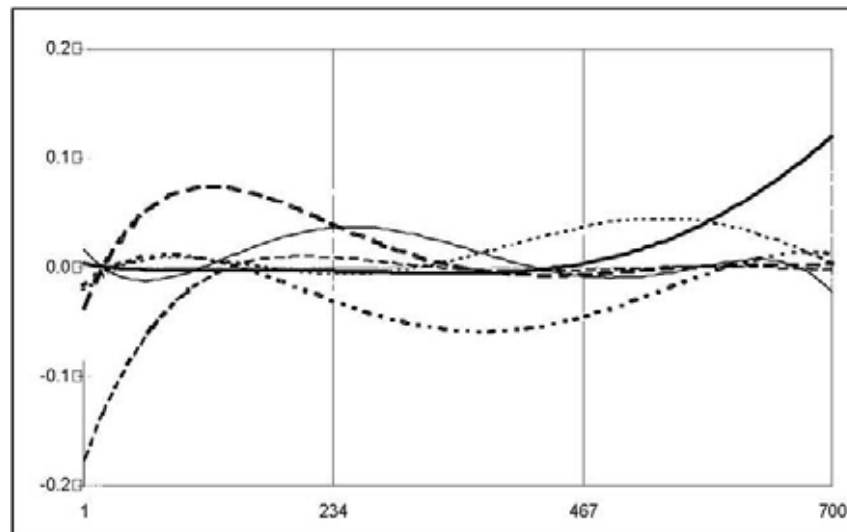


Figure 9. Trajectories of all sub-processes.  
Points 1-700 with intensity ranging from -.20 to +.20

## Literature

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## UNIVERZALNA METODOLOGIJA IDENTIFIKACIJE PROCESA

### Sažetak

Korištenjem modela simulacije razvoja pseudo-objekata u konačnom prostoru, uspješno su prepoznati i opisani subsegmenti cjelovito definiranog procesa. Ovi subsegmenti pokazuju dominaciju u usporedbi s ostalim subprocesima u pojedinom razdoblju. Na temelju pozicija pojedinih subsegmenata, ali i na temelju njihovih reakcija, granice dijelova informacija koje označavaju procese su identificirani i u terminima parametara određeni kao: Komunikativnost, Ekspanzija, Razina organizacije, Usklađenost, Stabilnost i Sklad. Korištenjem algoritma koji kumulativno locira taksone u Indifg poziciju, dobivene su potpuno dosljedne i neprekinute serije točaka koje opisuju važne faze svakog procesa: 1) oslobađanje inicijalne energije, 2) varijacije inducirane energijom, 3) skupljanje materijala, 4) spoznavanje ili učenje, 5) eksternu integraciju resursa i 6) pripremu za prijelaz u novi process ili na novu razinu. Ovaj članak nudi pravila, odnosno, univerzalne parametre i faze procesa koji su transparentni i lako primjenjivi u mnogim situacijama i u bilo kojem području.

**Ključne riječi:** proces, identifikacija, taksoni, vrijeme, razvoj

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## LATENT STRUCTURE OF SITUATIONAL EFFICIENCY OF ELITE JUNIOR BASKETBALL PLAYERS

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### Abstract

*The main goal of this research is to establish the latent structure of situational efficiency of elite junior basketball players. For this purpose, an exploratory factor analysis strategy by use of principal components method was implemented in 13 standard situation efficacy indicators on the sample of 108 elite junior basketball players who participated in the 19th Junior European Basketball Championship in Zadar, 2000. The sample of respondents consisted of competitors who averagely played 8 minutes per a game for more than 3 games, and they were chosen from 11 teams that played 46 games in the championship. Two relatively independent latent dimensions have been isolated and named as: situational technical and tactical activity factors of inside and outside players. It has been concluded that neither the standard use of the variable of the situational efficiency, nor the use of the latent dimensions that have been derived from them suffice to fully explain the structure of basketball game.*

**Key words:** basketball game, situational efficiency, elite juniors, latent structure

### Introduction

From the point of view of movement structure and the structure of game situations, basketball is one of the most complex and variable team games, dominated by fast transformations from action to action (Trninić, 1995). Furthermore, Javier (1992) states that basketball is a dominantly strategic sport or strategic team game in which every player synchronizes his individual technique and tactics with his co-players, through the collective tactics of the team. He also points out that in the game of basketball, strategic behavior comprises all parameters that determine the development of actions in the game: game rules, technique, tactics, space, time and communication. Consequently, that means that basketball is a contradicting sport with a game tactics model and an infinite number of possibilities to resolve game situations, while on the team level there is a cooperation – opposition model (Hernandez, 1987, 1988; Gréhaigne and Godbout, 1995), so harmonizing individual and team goals, i.e., individual and team resolution of game situations is an important ability (Trninić, Perica and Dizdar, 1999; Trninić and Dizdar, 2000; Gréhaigne, Bouthier and Godbout, 1997).

However, a basketball match can be interpreted as a defined sequence of jobs or tasks in the game that each player has to perform with regard to his place and role in the team, within a specific game tactics model. Game tasks differ not only according to the position of a player in a team, but also according to the structure of the required anthropological characteristics. Therefore, game tasks can be seen from the viewpoint of sports activity analysis and the analysis of dimensions responsible for their successful completion. Trninić, (1995) states that it is possible to explain situational efficiency of particular types of players.

It can be done based on game assignments on the level of structural and functional approach, because game assignments that a particular player performs within the game tactics model directly reflect on the situational efficiency of players on all positions in the game. In the analysis of game tasks through the stages of the course of the game, one can distinguish between tasks and individual situational efficiency for every position in set defense, offense transition, set offense and defense transition, according to the analysis of the video recording. The functional structure of basketball can also be viewed through technique/tactics and cooperation/opposition categories. Task performance in the game includes specific demands that refer to encumbrment (energetic, informational and emotional component), resolving and realizing particular situations in the game, the course of actions within the stages and the game tactics model, the specific anthropological characteristics and states responsible for the successful completion of tasks that a particular player has during a basketball match (Trninić, 1995). Presumably, situational efficiency indicators in the game of basketball are determined by the level of successful completion of individual and collective tasks that each player needs to perform with regard to his position (place) and functional role in the team. It refers to the various modes of task performance in the game that demand specific technical-tactical knowledge about how to do something, which enables the execution of actions. Accordingly, the basic rule that enables an organized game to function successfully is that each player keeps to his own responsibilities and authority (rights in the game), i.e. that each player knows exactly what his task is, and what is expected of him with regard to his position.

Pavlović (1977) divides all playing situations into typical (standard) and untypical (nonstandard). He also states that typical playing situations are the ones that are in a certain way more often found in the same form in the game course stages, which is why they shape the characteristic situations that occur several times during a match in the same way. Furthermore, he says that untypical playing situations are the ones that rarely occur during a match, are hard to read, and are "played" by players with special abilities who have an untypical way of resolving problems and make the game completely nonstandard. The problem with constructing a valid measuring instrument that can successfully interpret inadequate and positive dimensions of each player in situational and competitive environment is resolved with a sequence of statistical techniques. Therefore, it is very important to encompass a wide structure of relevant situational efficiency indicators that can be successfully registered at a basketball match. With this purpose in mind FIBA standardized 13 situational efficiency indicators that have been officially monitored at each match of the World Championship in Hamilton and Toronto, 4 to 14 August 1994. The suggested situational efficiency indicators are: the number of two-point field goals, the number of two-point field goal attempts, the number of three-point field goals, the number of three-point field goal attempts, the number of free throws (1, 2 and 3), the number of free throws (1, 2 and 3) attempts, defensive rebound, offensive rebound, assists, personal fouls, turnovers, steals and blockshots. The statistical overview of the above-mentioned matches of the World Championship showed that the number of two-point field goals was the primary situational parameter for the overall successfulness in the game, whose efficiency was averaging between 50 and 60 %, and comprised 55 to 60 % of the total number of points at a basketball match. Therefore, for a successful realization in the transition or position offense, it was necessary to set a structure of movement lines, which enabled a large number of running in and blockshots between the short – tall and tall – short players, and consequently arriving at the wanted selective (open) shot.

### Aim

Since the above-mentioned standard indicators of situational efficiency of basketball players do not occur in isolation, one can assume that their co-variability is dependant on a smaller number of latent dimensions, which are the grounds for interpreting the game of basketball from a functional point of view. Therefore, the goal of this research is to try and determine the latent structure of standard situational efficiency indicators registered during a basketball match to determine the presupposed functional dependence, and gain a fuller insight in their interaction.

### Research review

After having carried out a three-year study at some American universities using basketball players, Swalgin (1994) established the norms.

Those were norms for the assessment of the situational efficiency of basketball players according to the positions they played and their playing time. He designed an efficiency-related computer program for the assessment of basketball players whereby positive and inadequate dimensions of each player could be assessed with regard to his position in the game. Looking at works concerned with other sports games, only Janković (1988) researched and defined the latent structure of technical-tactical elements in the game of volleyball. The author took a sample of the best four volleyball teams that participated in the final tournament of the former Yugoslavia Cup (1981) and registered 20 basic data of a closed system of volleyball matches with the purpose to check the dimensionality and structure of volleyball game elements. The author used componential analysis to extract four main components significant under the Guttman-Kaiser criterion that coherently describe the structure of the game of volleyball, and named them as: overall game efficiency, lift efficiency, implementing backcourt elements efficiency and the game course during fast breaks. A smaller number of experts were researching the latent structure of situational space of sports games. For example, Trninić (1995) carried out a quantity analysis of the game of basketball with mathematical-statistically multivariate procedures. The analysis was made by using basic and specific game attributes and entities (game tasks), based on top-level and selected basketball experts – players and coaches and scientist-practitioners and their knowledge of the game. A correlation matrix was factored in the frame of explorative strategy with a factor analysis of attributes or variables under a component model.

Three factors were extracted after applying the Guttman-Kaiser criterion and they exhaust 76,9% of the total variance of the manifest area. The first factor (inside players) exhausts 32,4%, the second (course of the game) 23,7%, and the third (outside players) 20,8% of the total variance. The factor solutions gained show that the examined experts (players and coaches) comprehend the game of basketball in keeping with the theories of tactics. The same work features a factor analysis of specific attributes or variables under a component model. A correlation matrix was factored in the frame of explorative strategy and, after applying the Guttman-Kaiser criterion, 3 latent dimensions that exhaust 80,3% of the total variance of the manifest area were extracted. The first latent dimension (informational component of the game of basketball) exhausts 37,3%, the second (energy component – game intensity) 31,5%, and the third (sociomotoric interaction) 11,4% of the total variance. The correlation matrix between the OBLIMIN factors showed the connection between the informational component and sociomotoric interaction of 0,38. Most likely, at the basis of it is a common denominator, a cognitive component. A negative connection (-0,17) was noted between the energy component and sociomotoric interaction.

With regard to the determined latent structure in the specific attributes area (informational, energy and sociomotorical component of sports activities), it is assumed that this structure is necessary for game tasks realization. Trninić and al. (1995) also attempted to determine the latent structure of a basketball game by using ALPHA – factor analysis (initial coordinate system has been transformed by non-orthogonal rotation using oblimin criterion) by 13 standard indicators of the situational efficiency of a basketball game, recorded at 64 games of the World Basketball Championship held in Toronto, Canada in 1994. The authors isolated four relatively independent latent dimensions using Guttman-Kaiser criterion: 1. the efficiency of inside players or players of the back defense line and the front offense line, 2. the efficiency of outside players or players of the front defense line and the back offense line 3. general offense-related efficiency, and 4. the efficiency of throwing the ball into the basket from a distance. From the point of view of game roles, Thomson (1994) speaks of inside players (numbers 4 and 5) and post-technique with the back to the basket, while Wissel (1994) describes outside players (numbers 1, 2 and 3) and the specific qualities of the face to the basket technique. On the other hand, Javier (1992) divides players into two big categories with regard to the roles in the game, outside (organizer, realizer and wing) and inside (post and pivot man) players.

## Methods

### Sample

The sample is composed of 108 elite junior basketball players (42 guards, 26 forwards and 40 centers), participants of 19 European Championship in Zadar in 2000 (Table 1). Out of the total number of players only those who played averagely more than 8 minutes per game and 3 or more matches were included in the sample.

Table 1. Sample

| Team      | Number of respondents | Final rankings |
|-----------|-----------------------|----------------|
| France    | 12                    | 1              |
| Croatia   | 10                    | 2              |
| Israel    | 8                     | 10             |
| Slovenia  | 10                    | 9              |
| Greece    | 8                     | 3              |
| Lithuania | 11                    | 7              |
| Bulgaria  | 9                     | 12             |
| Russia    | 11                    | 6              |
| Italy     | 10                    | 4              |
| Latvia    | 8                     | 8              |
| Spain     | 11                    | 11             |

The average age of the basketball players was 17,8 years ( $\pm 0,7\sigma$ ). All respondents (apart from the players of the Yugoslavian team) have consented to participate in the study, based on a permit issued by FIBA. It is a representative sample of the best junior basketball players in Europe. Eleven basketball teams participated: France, Croatia, Israel, Slovenia, Greece, Lithuania, Bulgaria, Russia, Italy, Latvia and Spain.

### Variables

The sample of manifest variables is consisted of 13 standard indicators of situational efficiency.

Variables are standardly registered for every team in the match and they are: 1. *two-point field goals – successfully (S2US)* – the number of successful goals within 6.25m line, 2. *two-point field goal – unsuccessfully (S2NE)* – the number of unsuccessful goals within 6.25m line, 3. *three-point field goal – successfully (S3US)* – the number of successful goals beyond 6.25m line, 4. *three-point field goal – unsuccessfully (S3NE)* – the number of unsuccessful goals beyond 6.25m line, 5. *free throw (1,2 and 3) – made (SBUS)* – the number of successful goals behind the free throws line, 6. *free throw (1,2 and 3) – missed (SBNE)* – the number of unsuccessful goals behind the free throws line, 7. *offensive rebound (SN)* – the number of ball caught (rebounds off the rim or backboard) on the rebound in the phase of offense, 8. *defensive rebound (SO)* – the number of ball caught (rebounds off the rim or backboard) on the rebound in the phase of defense, 9. *assists (A)* – the number of balls passed to the "open" (undefended) player enabling a successful throw into the basket, 10. *personal foul (OP)* – the number of fouls; it implies a prohibited, irregular body contact with the opponent, no matter whether the ball is in play or it is a tie ball; fouls regarding the infringement of the rules of conduct (technical fouls), 11. *turnover (IL)* – the number of turnovers in the offense stage as a result of inaccurate assist, bad catch, bad ball dribbling and infringement of the rules (foot faults, intentional kicking of the ball, the ball out-of-bounds, double dribbling, carrying the ball, rule 3,5,10 and 30 seconds and the ball returned into the backcourt), 12. *steal (OL)* – the number of steals during the stage of transition or set defense following the team foul during the transition or set offense. Stealing ball during dribbling or cutting off passed balls are some of the ways for defense players to gain possession of the ball, 13. *blockshot (B)* – the number of blockshots during the stage of transition or set defense. The collected data are the official results that are recorded at every match according to the rules of the technical commission of FIBA. The data regarding the basketball results in the computer programs has been registered by persons specially trained for the job.

### Methods of data processing

Factor analysis of principal components extraction was applied in the framework of exploratory strategy, consistently with the goal of the research. The initial factor number was determined on the basis of the Guttman-Kaiser criterion and the initial coordinate system has been transformed by means of orthogonal rotation according to varimax raw criterion.

In the framework of the stated method calculations were made of: The basic statistical parameters, manifest variables correlation matrix, eigenvalues, explained and cumulative variance ( $\lambda\%$ , cum.%), communalities ( $h^2$ ), determination coefficient of multiple correlation of each variable with the others in the set (SMC) and saturation matrix for manifest variables with calculated factors.

## Results and discussion

Table 2. The descriptive statistical parameters for variables of situational efficiency

|           | N   | $\bar{X}$ | Min  | Max   | $\sigma$ | $\alpha_3$ | $\alpha_4$ |
|-----------|-----|-----------|------|-------|----------|------------|------------|
| SHOT1-SU  | 108 | 12,30     | 0,00 | 44,00 | 9,58     | 1,08       | 0,64       |
| SHOT1-UNS | 108 | 5,55      | 0,00 | 31,00 | 5,14     | 2,14       | 6,61       |
| SHOT2-SU  | 108 | 14,71     | 1,00 | 50,00 | 10,66    | 1,19       | 1,23       |
| SHOT2-UNS | 108 | 14,89     | 0,00 | 51,00 | 10,25    | 0,93       | 0,77       |
| SHOT3-SU  | 108 | 3,13      | 0,00 | 16,00 | 3,69     | 1,50       | 2,02       |
| SHOT3-UNS | 108 | 7,41      | 0,00 | 36,00 | 7,78     | 1,35       | 1,69       |
| REBOU-DEF | 108 | 1,78      | 0,00 | 6,20  | 1,20     | 1,38       | 2,37       |
| REBOU-OFF | 108 | 0,85      | 0,00 | 3,20  | 0,72     | 0,97       | 0,57       |
| ASSIST    | 108 | 0,88      | 0,00 | 5,10  | 0,85     | 2,26       | 7,48       |
| STEAL     | 108 | 1,18      | 0,00 | 4,20  | 0,84     | 1,52       | 2,35       |
| TURNOVER  | 108 | 1,54      | 0,00 | 4,70  | 0,85     | 0,89       | 1,26       |
| PERSFOUL  | 108 | 2,11      | 0,20 | 4,00  | 0,87     | 0,28       | -0,73      |
| BLOCKSHOT | 108 | 0,27      | 0,00 | 2,10  | 0,41     | 2,04       | 4,43       |

(N – the number of respondents,  $\bar{X}$  – arithmetic mean, Min – minimal result, Max – maximal result,  $\sigma$  – standard deviation,  $\alpha_3$  – skewness,  $\alpha_4$  – kurtosis)

Table 3: Correlation matrix for the manifest variables

|      | SBUS        | SBNE        | S2US        | S2NE        | S3US         | S3NE         | SO          | SN          | A           | OL          | IL          | OP          | B    |
|------|-------------|-------------|-------------|-------------|--------------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|------|
| SBUS | 1,00        |             |             |             |              |              |             |             |             |             |             |             |      |
| SBNE | <b>0,69</b> | 1,00        |             |             |              |              |             |             |             |             |             |             |      |
| S2US | <b>0,71</b> | <b>0,66</b> | 1,00        |             |              |              |             |             |             |             |             |             |      |
| S2NE | <b>0,66</b> | <b>0,49</b> | <b>0,74</b> | 1,00        |              |              |             |             |             |             |             |             |      |
| S3US | 0,17        | 0,01        | 0,00        | 0,10        | 1,00         |              |             |             |             |             |             |             |      |
| S3NE | 0,15        | -0,01       | 0,05        | <b>0,19</b> | <b>0,84</b>  | 1,00         |             |             |             |             |             |             |      |
| SO   | <b>0,67</b> | <b>0,64</b> | <b>0,74</b> | <b>0,65</b> | -0,05        | -0,01        | 1,00        |             |             |             |             |             |      |
| SN   | <b>0,44</b> | <b>0,52</b> | <b>0,57</b> | <b>0,52</b> | <b>-0,29</b> | <b>-0,26</b> | <b>0,70</b> | 1,00        |             |             |             |             |      |
| A    | <b>0,36</b> | 0,17        | <b>0,30</b> | <b>0,34</b> | <b>0,43</b>  | <b>0,52</b>  | <b>0,27</b> | -0,08       | 1,00        |             |             |             |      |
| OL   | <b>0,39</b> | <b>0,28</b> | <b>0,30</b> | <b>0,48</b> | <b>0,31</b>  | <b>0,37</b>  | <b>0,30</b> | 0,07        | <b>0,59</b> | 1,00        |             |             |      |
| IL   | <b>0,58</b> | <b>0,37</b> | <b>0,43</b> | <b>0,52</b> | <b>0,25</b>  | <b>0,28</b>  | <b>0,47</b> | <b>0,28</b> | <b>0,56</b> | <b>0,55</b> | 1,00        |             |      |
| OP   | <b>0,38</b> | <b>0,32</b> | <b>0,36</b> | <b>0,41</b> | 0,01         | 0,05         | <b>0,34</b> | <b>0,35</b> | 0,06        | <b>0,22</b> | <b>0,28</b> | 1,00        |      |
| B    | <b>0,30</b> | <b>0,47</b> | <b>0,41</b> | <b>0,29</b> | <b>-0,22</b> | <b>-0,19</b> | <b>0,56</b> | <b>0,57</b> | -0,08       | 0,00        | 0,08        | <b>0,34</b> | 1,00 |

Statistically significant correlation coefficients on the significance level of 0.05 are in bold type.

Sample analysis shows a mild positive asymmetry in the following variables: PERSFOUL ( $\alpha_3 = 0,28$ ), TURNOVER ( $\alpha_3 = 0,89$ ), SHOT2-UNS ( $\alpha_3 = 0,93$ ) and REBOU-OFF ( $\alpha_3 = 0,97$ ). A somewhat more emphasized asymmetry can be seen in most of the other variables whose values range from 1,08 to 1,52 (for example, SHOT1-SU, SHOT3-UNS, REBOU-DEF). A highly emphasized positive asymmetry can be seen in variables: BLOCKSHOT ( $\alpha_3 = 2,04$ ), SHOT1-UNS ( $\alpha_3 = 2,14$ ) and ASSIST ( $\alpha_3 = 2,26$ ). Satisfactory kurtosis values are found in variables whose values  $\alpha_4$  range from 0,57 to 0,77 (REBOU-OFF, SHOT1-SU, SHOT2-UNS). Mildly negative result value can be seen in variable PERSFOUL ( $\alpha_4 = -0,73$ ).

Marked test sensitivity is shown by the following variables: SHOT2-SU, TURNOVER and SHOT3-UNS, whose  $\alpha_4$  values range from 1,23 to 1,69. More emphasized kurtosis values can be seen in variables SHOT3-SU ( $\alpha_4 = 2,02$ ) and STEAL ( $\alpha_4 = 2,35$ ). Furthermore, high kurtosis values of the overall sample can be seen in variables SHOT1-UNS ( $\alpha_4 = 6,61$ ), ASSIST ( $\alpha_4 = 7,48$ ) and BLOCKSHOT ( $\alpha_4 = 4,43$ ) and that is also a warning about the high test sensitivity. In the correlation matrix (Table 3) a major link between the analysed variables can be seen. Out of the total of 78 correlation coefficients, it is significant that as much as 60 is on a significance level of 0,05, which is a mere 77% of the total number, ranging from -0,19 to 0,84.

The highest number of the statistically significant correlation coefficients (11) with the other variables is between the two-point field goals – unsuccessful and turnovers variables, therefore, they cause the greatest part of the covariabilities in the area of the situational efficiency indicators in the game of basketball. As many as 5 variables (SBUS, S2US, SO, SN, OL) is statistically significantly correlated with 10 out of the remaining 12 variables. Trninić et al. (1995) state in their empirical findings that out of the total number of goal attempts, 52,13% of points scored, i.e. 55,48% of points scored refers to two-point field goals. It is therefore understandable that the two-point field goal – unsuccessful and turnover variables are the greatest covariability generators in the total situational area. The numerical magnitude of the correlation coefficient (0,84) between the three-point field goal – unsuccessful and the three-point field goal – successful points toward a clear connection between the frequency of shots fired beyond 6.25m line (three-point field). Using factor analysis and the method of *principal components* a correlation matrix was factored in the frame of explorative strategy. Two latent dimensions that exhaust 64% of the total variance of the manifest area were extracted by the application of the Guttman-Kaiser criterion. The first latent dimension exhausts 40% and the second 24% of the total variance (Table 4). These percentiles are relatively high and understandable with regard to the structure of the correlation matrix.

Table 4: Eigenvalues

| factor   | $\lambda$ | $\lambda \%$ | kum% |
|----------|-----------|--------------|------|
| <b>1</b> | 5,37      | 40           | 40   |
| <b>2</b> | 2,88      | 24           | 64   |

The initial coordinate system of two extracted factors has been transformed by means of orthogonal rotation according to Varimax raw criterion. Table 5 shows the results of the factor analysis for the system of 13 variables for evaluating situational efficiency of top European junior basketball players in the overall sample of 108 players who averagely played three and more matches and eight and more minutes per match.

Table 5. Parallel projections matrix for manifest variables with rotated factors, the coefficient of multiple determination (SMC) and communalities for manifest variables ( $h^2$ )

|           | F <sub>1</sub> | F <sub>2</sub> | SMC  | $h^2$ |
|-----------|----------------|----------------|------|-------|
| SHOT1-SU  | <b>0,79</b>    | 0,30           | 0,71 | 0,71  |
| SHOT1-UNS | <b>0,78</b>    | 0,04           | 0,61 | 0,61  |
| SHOT2-SU  | <b>0,85</b>    | 0,12           | 0,73 | 0,74  |
| SHOT2-UNS | <b>0,78</b>    | 0,29           | 0,70 | 0,69  |
| SHOT3-SU  | -0,12          | <b>0,81</b>    | 0,73 | 0,67  |
| SHOT3-UNS | -0,08          | <b>0,85</b>    | 0,76 | 0,73  |
| REBOU-DEF | <b>0,88</b>    | 0,03           | 0,74 | 0,78  |
| REBOU-OFF | <b>0,78</b>    | -0,32          | 0,65 | 0,72  |
| ASSIST    | 0,23           | <b>0,77</b>    | 0,59 | 0,65  |
| STEAL     | 0,36           | <b>0,64</b>    | 0,50 | 0,55  |
| TURNOVER  | 0,54           | 0,54           | 0,55 | 0,59  |
| PERSFOUL  | 0,53           | 0,04           | 0,27 | 0,28  |
| BLOCKSHOT | 0,63           | -0,35          | 0,47 | 0,52  |

The first significant factor describes 40% of the total applied variables system for evaluation of situational efficiency and it has marked correlations with SHOT1-SU, SHOT1-UNS, REBOU-DEF, REBOU-OFF, PERSFOUL and BLOCKSHOT variables. Therefore, one can talk about the factor of inside players' situational activity, i.e., their game tasks, which are evident in situational efficiency variables that determine the latent dimension of technical-tactical activity of inside players at a competition. Presumably, at the stated factor are positively projected players who play on positions 4 and 5, and whose organization of defensive and offensive activities is primarily in the restricted area. For example, inside players primarily realize offenses in the vicinity of the basket with and without ball handling and are responsible for opening the first outside pass in the initial phase of offense transition. Inside game consists of action units that contain dribble penetration, inside running, inside passes and offensive rebound. Expert coaches consider breaking defense to be the first principle of a successful offense (Winter, 1997), as much as stopping dribble penetration is the first principle of a successful team defense (Trninić, 1996). Plays under the basket create chances for drawing a great number of personal fouls on players who primarily play on the inside positions by which they come into situations to shoot numerous successful or unsuccessful free throw shots. Also, on the account of their technical-tactical activities under their own basket, inside players have more opportunities to successfully blockshot in the defense stage.

Therefore, this latent dimension is above all defined by variables characteristic for players who primarily act in the area under the basket (mainly positions 4 and 5). The second significant factor describes 24% of the total system variance and highly correlates with SHOT3-SU, SHOT3-UNS, ASSIST and STEAL variables. This latent dimension is marked by situational efficiency indicators that are characteristic for outside players (positions 1, 2 and 3). It is because tasks in the stages of transition and position defense performed by outside players (ball pressure and passing lines in the front defensive line) determine a bigger number of steals. On the other hand, the activities of players in the back offensive line open the possibilities for shooting beyond the 6,25 line and passing the ball which precedes selective shots – assists that increase offense efficiency. It is important to point out that outside players directly determine the offense organization quality, as well as organizing pressure on the front defense line. They have positions and moves, but also primary roles of assisting and outside shooting, which gives them opportunities for a number of successful and unsuccessful three-point shots, as well as assists.

## Conclusion

The basic goal of this research was to establish and explain latent structure of situational efficiency variables in elite junior basketball players in order to determine their functional dependency and gain a fuller perspective on their mutual interaction. To this end, an explorative strategy of principal components extraction was applied with Varimax raw transformation of the initial coordinate system to 13 standard indicators of situational efficiency, which were monitored on 46 matches of the Junior European Basketball Championship in Zadar in 2000. In the process, two factors that account for 64% of the total variability were isolated. The first significant factor markedly correlates with variables SHOT1-SU, SHOT1-UNS, REBOU-DEF, REBOU-OFF, PERSFOUL and BLOCKSHOT, so one can assume there is a factor that accounts for the technical-tactical activities of inside players at a competition. The other significant factor highly correlates with variables SHOT3-SU, SHOT3-UNS, ASSIST and TURNOVER, so in this case one can talk about a factor that accounts for the technical-tactical activities of outside players.

The factors comprise two isolated latent dimensions, i.e. functionally related structures of situational efficiency indicators. The functional division of players on outside and inside was substantiated in accordance with the above-mentioned. One can conclude that neither the standard use of situational efficiency variables, nor latent dimensions that were derived from them are enough to fully explain the structure of the game of basketball, because determining and interpreting latent structure on the basis of standard indicators of situational efficiency does not explain their entire functional dependency, thereby not giving complete insight into their interaction.

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## LATENTNA STRUKTURA SITUACIJSKE UČINKOVITOSTI ELITNIH KOŠARKAŠA - JUNIORA

### Sažetak

Glavni cilj ovog istraživanja je utvrđivanje latentne strukture situacijske učinkovitosti elitnih košarkaša juniora. U tu svrhu, primjenjena je eksplorativna strategija faktorske analize glavnih komponenata 13 standardnih pokazatelja situacijske učinkovitosti na uzorku od 108 elitnih košarkaša juniora koji su usdjelovali na 19-om Juniorskom košarkaškom prvenstvu u Zadru 2000.g. Uzorak ispitanika se sastojao od natjecatelja koji su prosječno proveli u igri 8 minuta u više od tri utakmice, i bili su izabrani iz 11 momčadi koje su odigrale 46 utakmica na prvenstvu. Izolirane su dvije relativno neovisne latentne dimenzije i imenovane su kao: situacijska tehnička i taktička aktivnost 1) unutrašnjih i 2) vanjskih igrača. Zaključeno je kako niti korištenje standardnih pokazatelja situacijske učinkovitosti, a niti korištenje iz njih deriviranih latentnih dimenzija nisu dostatni za objašnjenje strukture košarkaške igre.

**Ključne riječi:** košarkaška igra, situacijska učinkovitost, elitni juniori, latentna struktura

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## FACTOR ANALYSIS OF MORPHOLOGICAL CHARACTERISTICS OF YOUNG ELITE SWIMMERS OF BOSNIA AND HERZEGOVINA

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### Abstract

*On the sample of 10 selected swimmers, national junior champions and national junior record holders of B&H, was applied a system of 26 morphological variables. The main issue was to determine quantitative degree of correlation of hypothesis factors which are responsible for correlations between manifest variables in this research. The number of morphological variables was reduced with relatively less number of independent latent variables. Those latent morphological variables can explain mutual relations of analysed set of manifest variables in tested swimmers. Three independent morphological factors were determined: longitudinal dimension factor, factor of free fat and transversal dimension factor. Those factors were in the certain degree related. Orthoblique factors were revealed relation between longitudinal dimension and transversal dimension with high correlation 0.7609, while factor of free fat was separate factor. The most marked morphological separate variables were variables of transversal dimensionality: wrist diameter (ADRZ), knee diameter, ankle diameter, hand bandwidth (ASSA), foot bandwidth (ASST), biacromial bandwidth (ABIK). It is obvious that specially formed structures of morphological dimensions of elite level swimmers are result of genetic predisposition, selection and training process in swimming.*

**Key words:** morphology, young elite swimmers, factor analysis

### Introduction and aim

Morphological characteristics of the athletes describe the material of his body. Constitutional characteristics are particularly important factor for success in sport. Every sport places specific demands in relation to body build, and the sports complex, even for individual roles and playing positions and characteristics differ. Morphological status of athletes is an important component that affects the functional ability of the organism and causes predisposition for certain sports. Swimmers, perhaps more than other athletes, conditioned by their morphological structure and adapted to work in the medium in which the anthropometric characteristics come to the personal expression.

Many authors have studied the morphology of the swimmers and their impact on performance in swimming, so (Popo, 2009) conducted research of 10 promising swimmers representatives of BiH, and make certain conclusions about the influence of anthropometry on the results in swimming, (Leko and Grcic -Zupčević, 1990) carried out research on a sample of 77 girls with the aim of determining the predictive value of a specific set of anthropometric dimensions to the speed of learning swimming. Relations special motor in relation to the efficiency of learning are engaged in swimming (Volčanšek and Matkovic, 1990), a sample of 118 boys. Čolić and Volčanšek (1990) on the same sample is trying to provide the scientific basis of the problem parameters influence on the performance tests, anthropometry learning swimming. The most significant relationships were observed between swimming performance and biological age.

The oldest girl, according to the expectations of the author, and were most mature physically. Moreno et al. (1995) were investigated included 272 swimmers quality levels in the 100 and 200 meter events front crawl technique. The subject of this study consisted of determining anthropometric and technical scale swimmers. Stager and Babington (1995) speak about the changes that occurred in the U.S. swimmer in the last two decades, with respect to biological maturity. The population of competitors is now older and it seems that the sport is now dominated by those who would later mature and characterized by greater body height and shoulder width. As can be seen dealing with this problem and most other research consists in finding a complex morphological dimension that is most ideal for achieving top results in swimming. Accordingly, the aim of this study consisted in determining the efficiency of the transformation process of programmed swimming training on the morphological dimensions to determine the structure of the national team swimmer tested BiH.

### Methods

Measurements provided in this study were conducted at the Center for diagnostic studies at the Faculty of Sport and Physical Education in Sarajevo. Testing was conducted on a sample of 10 (ten) swimmers, state representatives of BiH in swimming, the participants state championships BiH 2007th. For the final treatment results were included respondents who participated in the measurement and control in the competition and diagnostic testing after the championship.

In the selection of variables taken into account that they suit the characteristics of the respondents age, physical conditions and the available instruments, but above all to well cover most of the four-morphological space, and hypothetical factors isolated in previous relevant research. Accordingly, the choice of variables, in order to swimmers in this study can objectively describe the morphological dimensions that define them. This choice is made according to commonly accepted models of the structure of morphological space. From the analysis included it is presented factor analysis with orthoblique parallel solution (Bonacin, 2004).

Table 1. Variable of morphological space

| <b>Longitudinal dimensions</b>     |                          |
|------------------------------------|--------------------------|
| AVIT                               | Body height              |
| ADUR                               | Arm length               |
| ADUN                               | Leg length               |
| ADPL                               | Forearm length           |
| ADPK                               | Tibia length             |
| ADST                               | Feet length              |
| <b>Body weight and volume</b>      |                          |
| ATEZ                               | Body weight              |
| AOGK                               | Mean chest circumference |
| AOTR                               | Abdominal circumference  |
| AONL                               | Upper arm circumference  |
| AOPL                               | Forearm circumference    |
| AONK                               | Thigh circumference      |
| AOPK                               | Leg circumference        |
| <b>Transverse dimensions</b>       |                          |
| ABAK                               | Biacromial range         |
| ADIL                               | Diameter of the elbow    |
| ADRZ                               | Diameter of the wrist    |
| ADIK                               | Diameter of the knee     |
| ADSK                               | Diameter hock            |
| ASSA                               | Hand width               |
| ASST                               | Feet width               |
| ABIK                               | Bikristal range          |
| <b>Subcutaneous adipose tissue</b> |                          |
| ANNL                               | Upper arm skinfold       |
| ANPL                               | Forearm skinfold         |
| ANTR                               | Abdominal skinfold       |
| ANPK                               | Tibia skinfold           |
| ANLE                               | Skinfold of the back     |

## Results and discussion

Model of this study is defined in such a way as to identify a problem that should be explored, and procedures for processing are defined only after the problem thoroughly box set. Such behaviour help to avoid usage of irregular methods of treatment, because due to the complexity of a large number of well-known method simply inapplicable. This is especially true in a situation that is often encountered in sport, and these are small samples, where the rule entirely different statistical rules rather than in large samples. In fact, as you know, good research can be done if the sample only one participant, but then the problem of the framework and model of data processing must be special. Precisely such a situation, in this study.

As seen in Table 2 variable in morphological space in the clearest way to show that the morphological parameters of swimmers largely specific and as such are crucial to understanding the results of the swimming sport and develop the training process.

Table 2. Morphological oblique factors

|      | OBQ1  | OBQ2  | OBQ3  |
|------|-------|-------|-------|
| AVIT | 0.91  | -0.05 | 0.09  |
| ADUN | 0.87  | -0.02 | 0.05  |
| ADPL | 1.04  | -0.05 | -0.06 |
| ADPK | 1.09  | -0.10 | -0.14 |
| ADST | 0.54  | -0.07 | 0.49  |
| ADUR | 1.02  | -0.01 | -0.22 |
| ABAK | 1.01  | -0.06 | -0.15 |
| ADIL | 0.81  | -0.18 | 0.26  |
| ADRZ | 0.34  | -0.05 | 0.61  |
| ADIK | -0.15 | -0.07 | 1.00  |
| ADSK | -0.38 | -0.03 | 1.02  |
| ASSA | 0.24  | 0.22  | 0.71  |
| ASST | -0.32 | -0.02 | 1.00  |
| ABIK | -0.40 | 0.88  | 0.34  |
| ATEZ | 0.76  | 0.12  | 0.23  |
| AOGK | 0.95  | 0.18  | -0.08 |
| AOTR | 0.61  | 0.44  | 0.09  |
| AONL | 0.54  | 0.35  | 0.30  |
| AOPL | 0.67  | 0.22  | 0.24  |
| AONK | 0.32  | 0.57  | 0.31  |
| AOPK | 0.01  | 0.05  | 0.89  |
| ANNL | -0.11 | 0.95  | -0.25 |
| ANPL | -0.17 | 0.93  | -0.12 |
| ANTR | 0.17  | 0.93  | -0.27 |
| ANPK | -0.39 | 0.94  | -0.25 |
| ANLE | 0.28  | 0.66  | 0.26  |

In morphological space separately obtained three factors. They were obtained in a very specific way. We will start from the third because it is particularly interesting. Transverse dimensions that define this factor were defined by four variables: knee diameter, diameter of the hand, hand breadth and width of the foot. As you can see these are all parts of the distal extremities, which means that the swimmers there is a particular characteristic, whether genetic, either by selection, either themselves training, which produces morphological structure in a way that this is not a common situation as you might in a normal population or populations of other athletes. It may happen that some other athletes have this structure, but we can not say without a deep clean operation in a number of additional research. However, it probably will not always happen to such a structure - to be the distal segments, especially the transverse, so important and highly stressed as they are here. Transversal dimensions of like biakrominal range bikristal range diameter knees are not in this factor, which means that the swimmer is no specific relationship between parts of the body which is responsible for swimming, if you are the best. That is not a world record holder does not mean anything, they were selected and genetically predisposed means and selected and trained, therefore, it is likely that such morphologically complex wishes just for swimming.

What this means in the training process, which in methodological approach, which ultimately means to achieve results is not difficult to imagine. Also there is one thing interesting, and that is that this is the factor that joined the extent of the leg, which means that the extent of the leg (obviously measure of volume) indicates that, on at least a little more belongs to these transverse dimensions. Should not imagine how this man looks like when you would not know its other dimensions. It has emphasized the value of a similar growth pattern of these four elements that we described before and the fifth this band tibia. So, when you perceive to be already formed a picture as a swimmer, a top swimmer in BiH, and we said they are nearing a top, should look like morphology. What this means for training, the methodological approach and the result, it becomes very clear. Another factor is very simple, it is fat, full fat and no other especially pronounced in size, with some highlights bikristal range. This would mean that the adipose tissue similarly growth and development in swimmers have elements bikristal range. Now back to see how these boys look like. It is not excluded that it was desirable for the development of these transverse dimensions do not follow some other parameters and perhaps it is desirable that the growth and development of adipose tissue in terms of energy followed exactly bikristal range, because it is very probable energy segment, but which affects the seaworthiness and perhaps helps propulsive, buoyancy, etc. And, of course, the first factor that brings most of the elements, the most variable takes on himself, which means that the best saturated, consists of fifteen variables, there are all dimensions longitudinal, length dimensions, height, arm length and all other than the feet and hands, the transverse dimensions and, of course, the whole volume. By all accounts training process, selection, and all other products in particular the formation of particular model because it is a kind of capacity (in principle as to the scope of larger muscles capable) of course, that does not fall within the physiological characteristics, but we are talking about mechanical. In this case, expected to be in a particular way (eg, spindle) to develop the muscles of swimmers and significantly differ from those in, for example, basketball or weightlifting. The medium here is different and therefore longitudinal and volume related. Accordingly, there is a special characteristic between these two subdimensions that on one dimension. So the first factor as the first dimension, we have two parts which are equally directed, meaning bone growth in length, follows the development of volume, but it goes up to certain limits.

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So, if the first factor, as it is, longitudinal the volume in Table 3 we can see that this is one very specific characteristics of swimmers that is otherwise such, if the transversality associated with distal limb segments to the third factor, and if another factor in adipose tissue, then we need to see how they relate to each other, correlation factors, say the following: first and third are associated with a 0.76, which is quite high, the relationship between the type of volume and body length, ie, long bones, bone growth in length and volume with one hand, very high correlation with that growth transverse dimension of the distal segments, and this is again a special mechanism, which is again likely to feature just swimming and not the other samples, sports, etc.

Tabela 3. korelacije ortoblique faktora

|      | OBQ1 | OBQ2 | OBQ3 |
|------|------|------|------|
| OBQ1 | 1.00 | 0.35 | 0.76 |
| OBQ2 | 0.35 | 1.00 | 0.17 |
| OBQ3 | 0.76 | 0.17 | 1.00 |

Adipose tissue is much less connected to these two factors is of course expected. In general, among young athletes, but is not formed, we have soft and hard tissue. Under the soft tissue we include: adipose tissue and muscle tone, volume, the hard tissue growth in length, growth in width. This is not so. For example, this study shows that a morphologically complex swimmer specifically structured.

## Conclusion

Based on the research results we can conclude that the morphologically complex swimmer specifically structured. If they are already largely formed swimmers, and to assume that they are, then this is the final result of the operation, selection, genetic predisposition and training. If this is indeed the best and if the measurements are correct (as are), then this is the goal of morphological dimensions, this must be structured in each individual - a swimmer. However, our results should be checked on a much larger sample of top swimmers, so that later we could make some laws that relate to a specific set of morphological elite swimmers. This study showed the direction in which it is possible to focus efforts and knowledge in order to obtain optimal morphological structure that seeks specific swimming model (Đedović, D., 2009).

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## **FAKTORSKA ANALIZA MORFOLOŠKIH ZNAČAJKI PLIVAČA MLADIH REPREZENTATIVACA BOSNE I HERCEGOVINE**

### **Sažetak**

Na uzorku od 10 selekcioniranih plivača, višestrukih prvaka i rekordera, državnih kadetskih i juniorskih reprezentativaca BiH, testirano je ukupno 26 varijabli morfološkog prostora sa ciljem da se precizno kvantitativno utvrdi stepen povezanosti svakog od činilaca za koji se pretpostavlja da su odgovorni za korelacije između manifestnih varijabli koje tretirane ovim istraživanjem. Dakle, u ovom istraživanju je veliki broj međusobno povezanih varijabli u morfološkom prostoru kondenziran i reduciran u manji broj međusobno relativno nezavisnih latentnih varijabli koje mogu objasniti međusobne relacije analiziranog skupa manifestnih varijabli kod testiranih plivača. U morfološkom prostoru zasebno dobijena su tri faktora longitudinalne dimenzije, masno tkivo i transverzalne dimenzije koji su u određenoj mjeri povezani. Naime korelacije ortoblique faktora kažu da je povezanost između longitudinalnih dimenzija i transverzalnih dimezija 0.7609 što je dosta visoko, dok je masno tkivo relativno zaseban faktor. Od pojedinačnih varijabli najizraženije su transverzalne dimenzije dijametar ručnog zgloba (ADRZ), dijametar koljena (ADIK), dijametar skočnog zgloba (ADSK), širina šake (ASSA) širina stopala (ASST), bikristalni raspon (ABIK). U svakom slučaju očigledno je da uvelike formirani plivači, odnosno oni plivači koji se bave vrhunskim plivanjem imaju specifično struktuirane morfološke dimenzije koje su finalni rezultat rada, selekcije, genetskih predispozicija i treninga.

**Ključne riječi:** morfologija, mladi elitni plivači, faktorska analiza

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## INTRODUCTIONARY VIEW ON ISSUES CONCERNING HUMAN RESOURCES MANAGEMENT IN CROATIAN SPORTS

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Professional paper

### Abstract

*Management of human resources in Croatian sports has been very little observed or not observed at all, until now. Due to this fact we can only observe the last decade – first decade of 21st century – and we can see that the sports results from last few years are below general expectations, especially if we consider the psychophysical potential and talent in sports of population of this area as well as natural and infrastructural conditions for sports activities in this area. But, we can talk a lot about the underachievement of sports results in collective sports, especially on a level of team sports. The cause of this problem can be found in nonexistent strategy of management of human resources in sports' collectives. And this trend that has prevailed seems to be continuing to evolve in the future without any signs of responsible and systematic management of human resource with exact selective criterion and evaluation of overall work and results.*

**Key words:** management of human resources, sports organization, life-long learning, personnel

### Introduction

Management of human resources in every field of human activities, as well as in sports activities, presents one of those factors in which it is crucial to influence the quality of work results (sports results), optimization of relations between what has been invested in the project (expenses) and what has been achieved in terms of project income, and, of course, to influence the contribution of sport in the process of upbringing and education of youth, especially those who take part in sports activities. Also, management of human resources in sport influences the level of quality of living of the whole community in which sports collective takes part which can have positive consequences on financial income of the community as well as on creating optimistic atmosphere among the citizens – supporters and it can also influence the identification of image of social community with sports brand.

### Human resources management in Croatian sports

The main resources that the organization hires are material, financial and human resources. The role of management of human resources is that through various activities like planning the personnel, recruiting (internal and external), selecting between the recruits, training and developing personnel potentials, valuation of performances and work compensation, ensures the adequate structure of employees that poses the knowledge, skills and behaviour necessary for achievement of goals. It is the human resource that with its engagement affects the development and success in the whole sports organization. It is virtually impossible to imitate human resources because "what differs it is that overall organizational, intellectual, professional and other capabilities are not the summary of individual capabilities.

New quality that, depending on other factors (overall practise and programmes of management of human resources, management style, organization culture, structure, general social relations, etc.), can be bigger or smaller" (Bahtijarević-Siber, 1999). Special segment of human resources in sport are surely the volunteers without whom the functioning of sport that is a part of radio intensive activities, especially amateur ones, could not be possible. Also, sports manifestations like all kinds of competitions, world and European championships, Mediterranean games, Olympics, would be impossible to organize without volunteers that usually participate because of their love for sports. Sports organizations have more and more come to conclusion that the most important resources they poses are not the buildings, technology or funds, but people who are because of their unique values and capabilities competitor's advantage. The specificity of sports organizations is that "management of human resources in these organisations is aimed at two different kinds of employees: sportsmen and others" (Covell, Walker, Siciliano, Hess, according to Bartoluci and Škorić, 2009). Namely, a sports organization cannot be successful without quality sportsmen. Of course, they require special management treatment. This raises an important question: How to keep the sportsmen, who have outgrown the financial capabilities of their sports club? It is difficult to give a simple answer to this question, but surely, the sportsman in question will hardly leave the team if he feels a strong belonging to this organization, if he is satisfied with organizational culture and atmosphere, in other words, if he is satisfied with the way he is treated by those who manage the club. The question of professional staff (coaches, teachers, pedagogies) is one of the most important problems in the Croatian sport.

It seems that clubs do not have the interest to invest into long term profession, and without this none of the sports organizations can be successful because "knowledge becomes the crucial capital and the biggest competition strength of the company that transforms itself into learning organization, and this is how people, human resources, personnel become the key strategic advantage of the organization" (Buble, 2006). Insufficient education in management that does not cover enough manager's skills training as well as education of all other employees, is one of the reasons for inferiority of Croatian sports organizations in comparison to those in Europe. It is obviously necessary to improve the system of education and improving of employees in sports organizations according to conception of life-long learning that is based on the fact that knowledge rises with exponential speed, while production and technological processes become more complex but they are still no less complicated social relations. Because of the rapid dating of gained knowledge, due to the changeable demands within technological and social development, there is a need for permanent education to overcome the tasks regarding work, society, politics and sport. Sports organizations must act according to principles of contemporary management, in other words, they must consider management as "process of working with others and with help of these others to achieve the organization aims in changeable environment with effective use of limited resources" (Kreitner, 2005).

### **Problem and aim**

In hierarchical management structures of sports collectives in Croatia it is noticeable that people are being selected in different ways to perform certain duties and these are often rambling structures of selection or wide range of non-transparent criterion of evaluation of human potentials. This is why there are often people without vision and knowledge, sometimes even without any experience in managing sports collectives, performing duties in sports organizations. This is why many times we have witnessed inexperienced and incompetent governing of sports collectives that leads to insufficient level of game quality that again leads to bad results and inadequate mental and physical shape of our sportsmen on the field. This is comparable to collision of our sports collectives and sports collectives from other European countries where these organizational issues are evidently organized with better quality. Also, the consequences of insufficient competence of employees in sport on financial part of sports societies are immeasurable. This is why we are recently witnessing wide range of financial dubiousness in clubs and bankruptcy threats within famous sports clubs. All mentioned above leads to decrease of quality of sports performance, decrease of rating figures, interest of public and media for sport events, and it all directly affects the downfall of club income from tickets, marketing and TV-authorisation.

So, as a consequence among other, of unselective personnel in sport, we come across the long year agony and/or collapse of sport collectives which have by their games and results left a permanent mark in war-booty books of home and European competitions, as well as in memories of sports lovers throughout Croatia and Europe. To elaborate the loss that community feels because of these epilogues is not necessary – they are obvious. In this and some following works we will try to give some basic guidelines for analysis of situation in management of human resources in the Croatian sport so we could, in the future, on professional level try to change equivalent solutions for improvement and criterions in management of human resources.

It is important to stress some of the common forms that exist in selection of personnel that manage the sports collectives in our country:

1. Personnel from political structures: as a consequence of the fact that sports collectives, as brands, are mostly connected to local community and are today generally registered as citizens associations, with regards to the fact that it is a matter of prestige and social image to participate in certain collectives, statues of many sports societies have made possible that representatives of local political structures govern the clubs, sometimes even with influence on state level with idea that this is the best way to enable the more quality finance of sports club activities. In reality, we have seen many times that this practise has lead to nepotism in personnel and governing professional pyramid of work in clubs, disrespect of competence, knowledge and professional qualities needed to perform responsible functions in sport, unallotted spending of funds of taxpayers and often to satisfying partial financial interests on the cost of resultant and financial interest of sport collective governed by individuals from political structures. As a final consequence, these sports collectives have fallen into serious financial dubiousness and (un)cultural behaviour of individuals has had large repercussions on sociology of social relations.

2. Businessmen personnel: it is becoming more often that leading and management of sports clubs is taken over by representatives of successful companies which are also the largest sponsors of sports activities in particular sports collective. What is seen as a problem in this model of management of human resources in sport is inadequate experience in field of sport, that is, insufficient knowledge of processes of gaining sport results, lack of time for complete professionalization of sports functions, interfering with work of professional personnel who produce the results on the sports field and lack of punishment of this kind of interference, impatience in expectations of gaining profit from invested money which results in unsystematic sports business decisions and unnecessary cuts and shifts in field of sports, and it often also leads to complete withdrawal of investing company/companies from the project after a short period.

3. Ex-sportsmen: this model showed some success in the past, especially when it was combined with the model of participation of representatives from successful companies. However, the practice has often shown that successful sportsman does not have to necessarily be successful manager, as well as successful coach or educator (with a certain number of exceptions in both cases, although there were more of them among coaches) but it still happened that these retired sportsmen manage sports collective on different levels of management, although they have never had any specific knowledge, qualifications, or even capacity for quality management work in sports.

4. Individuals from the various financial backgrounds: although by investing their money, most often under the supervision of politic structures in sports societies or certain companies – sponsors of clubs, they achieved great sports and business results, very often this would happen in short period, while on the long term, partial interests would rise above interests of sports collective, so through time, sports results would very often become inversely proportionate to the property of investor or the whole project would cease. Today's unresolved legal status of sports societies in Croatia has helped a lot these individuals to become influential managers of clubs.

## Conclusion

From everything that is said here it is obvious that none of these models or combinations of models of management of human resources in sports

collectives since independency of Croatia, at least if we consider high and middle management levels, have, with few exceptions, completely satisfied general or public interest in rising the quality of sports games and sports results, as well as realised optimal governing of finance. It is evident that a completely new view of competences is needed regarding working in sports, responsibilities towards public and supporters, fair-play in behaviour towards financiers of sports projects and employees in sport, but also separation of ownership and management function in sports collective. But the most important is to set criterion of competence, knowledge and vision so that educated people can take over the sports societies and thus realize the quality step forward by sublimating all positive assumptions for work that are on disposal to our social community and individuals.

Since the quality management of human resources presupposes scholarly, expert and responsible approach in which, if we really want Croatian sport to rise in these financial inconvenient times, and in this way bring it closer to top European and world sports, there is no room for today's common patterns of behaviour like valorisation of all kinds of connections and friendship, returning favour for favour, surrendering to subjective estimations about who is good for leadership and management of sports collectives, etc. It is necessary to start almost from the beginning with different practical solution in management of human resources in our sport.

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## UVODNA RAZMATRANJA O PROBLEMATICI UPRAVLJANJA LJUDSKIM RESURSIMA U HRVATSKOM SPORTU

### Sažetak

*Upravljanjem ljudskim resursima u hrvatskom sportu se do sada posvećivalo malo ili nedovoljno pažnje. Shodno tome, rezultati koji su ostvarivani posljednjih godina na sportskim borilištima, a fokusirati se možemo ponajviše na posljednju dekadu, odnosno vrijeme prvog desetljeća 21. stoljeća, bili su i jesu ispod razine opravdanih očekivanja javnosti i publike, imajući u vidu sav psihofizički potencijal te talent ovdašnjeg pučanstva za širok spektar sportova i sportskih igara, te uzimajući u obzir prirodne i infrastukturne uvjete koje hrvatski sportaši imaju na dispoziciji. Napose možemo govoriti o trendu podbačaja rada i rezultata u kolektivnim sportovima, osobito na klupskoj razini, čemu je velikim dijelom kumovalo nepostojenje strategije upravljanja ljudskim resursima u sportskim kolektivima, a trend koji je prevladao čini se da se nastavlja i dalje u budućnosti, bez da je moguće primijetiti znakove da se upravljanjem ljudskim potencijalima želi pristupiti sustavno i odgovorno, rabeći egzaktnije kriterije selekcije i vrednovanja rada i rezultata.*

**Ključne riječi:** *upravljanje ljudskim resursima, sportska organizacija, cjeloživotno učenje, kadrovi*

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## RELATIONS BETWEEN FUNDAMENTAL MOTOR SKILLS AND SPECIFIC KARATE TECHNIQUE IN 5-7 YEAR OLD BEGINNERS

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*Original scientific paper*

### Abstract

*The aim of this study was to determine possible correlation of fundamental motor skills and specific karate skills in children age 5 to 7. A total of 31 children (21 boys and 10 girls) participated in this research and were subduced to two testing sessions: fundamental motor skills and specific karate skills. The fundamental motor skills were estimated with the use of the most commonly used test – TGMD-2. Three independent judges evaluated the performances of six specific karate elements watching the videotaped material. According to the high values of Cronbach alpha coefficients (0.91-0.98), Kolmogorov-Smirnov test and the results of the factor analysis we can conclude that the specific karate skills tests are a valid measurement for children age 5 to 7. Also, the absence of significant differences between boys and girls confirmed previous investigations in the area of fundamental motor skills. They do not differ significantly in the specific karate skills neither with girls having higher values. Karate skills are significantly positively correlated with the fundamental motor skills results (0.74). This correlation enables more appropriate selection process and the beginners training process organization were the aim is the fundamental motor skills quality development which proves to be the basis of specific karate technique learning in later stages.*

**Key words:** preschoolers, martial arts, TGMD-2, motor proficiency

### Introduction

Fundamental motor skills in preschoolers are one of the most studied areas (Fazzi et al., 2002; Levzion-Korach, Tennenbaum, Schnitzer & Omoy, 2000; Prechtel, Cioni, Einspieler, Bos & Ferrari, 2002; Tröster & Brambring, 1993; Tröster, Hecker & Brambring, 1994; Dummer, Haubenstricker & Stewart, 1996). However, those studies are highly oriented on motor deficiency detection in children with disabilities, while fundamental motor skills researches in healthy children are rare and often enclosing only a small part of the motor development. It is crucial to mention that children from age three to seven undergo a sensitive period for fundamental motor skills development (Gallahue & Donnelly, 2003). These skills enable moving through space (Zittel, 1994) and allow reactions on a great deal of external stimuli (Krebs, 2000).

Mastering these skills is a postulate for successful introduction to specific sport disciplines (Burton & Miller, 1998; Gallahue & Ozmun, 1998; Jürimäe & Jürimäe, 2000). Inadequate level of fundamental motor skills in the early age can be negatively reflected on motor competitiveness in adult age (Gallahue & Ozmun, 1998). They comprise of those movement patterns which are focused on reaching a certain goal, and according to Burton & Miller (1998) those are locomotion skills and object control skills. The two areas mentioned can be measured with one of the most frequently used tools: "Test of Gross Motor Development" (TGMD). The first (Ulrich, 1985), as the second (Ulrich, 2005) version proved to be a reliable and valid measure for fundamental motor skills assessment.

In the last decade karate became a massive sport discipline as well as other martial arts. It is a very complex sport discipline which inquires the integration of substantial amount of physical and mental characteristics. Mastering karate technique with automatization and their efficient application in combat require long-term and hard training (Katić, Blažević, Krstulović & Mulić, 2005). But in the beginning of their sport career the goal is to acquaint the children with a number of different techniques. Basic karate technique consists of learning single strikes, kicks, blocks and stances. Those skills are upgrading and improving in time which results upgrading to a higher belt. But although important, the basic karate skills are still not properly studied, except few interested researchers (Katić, Jukić, Glavan, Ivanišević & Gudelj, 2009; Katić et al. 2005). Distribution of injuries (Pieter, 2010; Macan, Bundalo-Vrbanac & Romić, 2006; Pieter, 2005) and biomechanical analysis (Mori, Ohtani & Imanaka, 2002) are far more investigated. Although it could be assumed that children with a higher level of fundamental motor skills can learn specific karate skills better and quicker, it has not yet been proved in karate. Besides studies about relations of fundamental motor skills and motor abilities (Overlock & Yun, 2006) or physical activity (Fisher, Reilly, Kelly, Montgomery, Williamson, Paton & Grant, 2005), none were found when it comes to relations with specific karate skills. The aim of this research was to determine possible correlation of fundamental motor skills and specific karate skills in children age 5 to 7.

For that purpose we calculated:

- Differences between boys and girls in fundamental motor skills,
- Differences between boys and girls in specific karate skills,
- Correlation of each specific karate skill and fundamental motor skills,
- Correlation of fundamental motor skills with total karate skills.

Possible significant correlation could directly influence the selection process as training process organization for beginners.

## Methods

### Participants

A total of thirty-one child (5 to 7 year olds) volunteered for this study (21 boys and 10 girls). All of them were members of the Karate Club "OBI" from Split. They trained seven months in average, three times per week for one hour with the same training volume and intensity and by the same coach. Prior to the investigation the parents had to sign an approval for participation.

### Measurements

For fundamental motor skills assessment we used a part of the TGMD-2 ("Test of Gross Motor Development-Second Edition") (Ulrich, 2005). This test is considered to be a qualitative measurement for children age range three to ten. The test is comprised of 12 motor skills arranged in two subtests: locomotor subtest (run, gallop, hop, leap, horizontal jump and slide) and object control subtest (striking a stationary ball, stationary dribble, catch, kick, overhand throw and underhand roll). Each skill is assessed by qualitative criteria (from 3 to 5 criteria, depending on a skill) and repeated 2 times. Every criterion is assessed with 0 (criterion not accomplished) or 1 (criterion accomplished). For example, if certain skill is assessed by three criteria, the result can vary from 0 to 6. The largest amount of points that can be obtained for each subtest is 48. Raw scores can be standardized according to participant's age with the use of accompanied tables. However, standardization was not used in this research because it only applies on the American population and is not necessarily valid for European children. It is important to emphasize that only locomotor subtest was used in this investigation based on karate not being a type of sport where object manipulation is present. The assessment was realized by a single judge because the test has proven to be a valid measure for preschoolers (Ulrich, 2000). Specific karate skills assessment was based on the same principles as the TGMD-2. Accordingly, 6 basic karate techniques: one punch (*choku zuki*), one kick (*mae geri*), three blocks (*gedan barai*, *age uke* and *ude uke*) and one stance (*zenkutsu dachi*); were rated by three criterions with the 0 and 1 marks. The maximum number of points was 36. The techniques were chosen and criteria were made according to the yellow belt exam program.

Three judges were involved in specific karate skills assessment because these tests have not yet been valued.

### Procedure

The experiment consisted of two phases. The first one, which took place 2 months after children's initiation in the club, included videotaping the fundamental motor skills which were then assessed by a single judge. Second phase was held five months after the first one and included videotaping the specific karate skills during the yellow belt exam.

### Data analysis

After calculating the *Cronbach alpha* coefficients for determining judge's objectivity in all of the six new tests of specific karate skills, Kolmogorov-Smirnov test was carried out for sensitivity determination. Validity of the tests was established by factor analysis and the following preliminary statistic parameters were calculated for both boys and girls: mean (AS), standard deviation (SD), minimum (MIN), maximum (MAX). Independent samples t test (t value) was used for determining gender differences. According to study aims, linear correlation analysis was calculated for determining the relationship between each specific karate skill and fundamental motor skills, as well as between fundamental motor skills and total karate skills (r).

## Results

Since TGMD-2 has been validated on a sample of preschool children (Cronbach alpha from 0.85 to 0.91) (Ulrich, 2000) and since only one judge did the assessment, it was not necessary to revalidate the test. But validation had to be done for the new specific karate tests (Table 1). All the tests had high values of Cronbach alpha coefficients (0.91-0.98). According to Kolmogorov-Smirnov test there were no differences between the observed and expected distributions ( $p < 0.05$ ), since the boundary for the d values was 0.24. When observing mean values of fundamental motor skills for boys and girls (Table 3) similar results appear and t test confirms the absence of significant differences ( $p > 0.05$ ). Also, observing the same values but for the specific karate skills, it can be noted that girls perform better although the t test did not show significant differences ( $p > 0.05$ ).

Table 1: Cronbach alpha coefficients and values of Kolmogorov-Smirnov test for each test

|                | Cronbach alpha | K-S  |
|----------------|----------------|------|
| TGMD           |                | 0.13 |
| ZENKUTSU DACHI | 0.92           | 0.10 |
| CHOKU ZUKI     | 0.96           | 0.14 |
| GEDAN BARAI    | 0.93           | 0.14 |
| AGE UKE        | 0.91           | 0.09 |
| UDE UKE        | 0.98           | 0.16 |
| MAE GERI       | 0.97           | 0.16 |

The girls dominate in the total karate skills as well but still with no significant differences. According to the presented, we can observe the girls and the boys as a unique sample for further analysis. Factor analysis of six specific karate skills revealed a single factor (Table 2) with 64% of explained variance. *Mae geri* kick had the highest projection (0.86) on the factor since it can be described as the most complex element.

Table 2: Results of factor analysis

|          | Factor 1 |
|----------|----------|
| ZD       | -0,80    |
| CZ       | -0,83    |
| GB       | -0,71    |
| AU       | -0,76    |
| UU       | -0,83    |
| MG       | -0,86    |
| Expl.Var | 3,83     |
| Prp.Totl | 0,64     |

Legend: ZD-Zenkutsu dachi, CZ-Choku zuki, GB-Gedan barai, AU-Age uke, UU-Ude uke, MG-Mae geri.

Table 3: Descriptive statistics: number of participants (N), mean value (Mean), standard deviation (SD), minimal result (MIN), maximal result (MAX); t test for independent samples: t-value (t).

|       | BOYS |       |      |       |       |
|-------|------|-------|------|-------|-------|
|       | N    | Mean  | SD   | MIN   | MAX   |
| TGMD  | 21   | 29.81 | 5.90 | 17.00 | 40.00 |
| ZD    | 21   | 3.98  | 1.09 | 1.33  | 6.00  |
| CZ    | 21   | 3.95  | 1.48 | 1.33  | 6.00  |
| GB    | 21   | 3.56  | 1.72 | 0.00  | 6.00  |
| AU    | 21   | 3.60  | 1.36 | 1.00  | 6.00  |
| UU    | 21   | 2.51  | 1.78 | 0.00  | 6.00  |
| MG    | 21   | 1.86  | 1.67 | 0.00  | 5.67  |
| TOT_K | 21   | 19.46 | 7.50 | 6.33  | 32.00 |

|       | GIRLS |       |      |       |       | t test |
|-------|-------|-------|------|-------|-------|--------|
|       | N     | Mean  | SD   | MIN   | MAX   | t      |
| TGMD  | 10    | 29.60 | 5.42 | 19.00 | 35.00 | 0.09   |
| ZD    | 10    | 3.90  | 1.19 | 2.33  | 6.00  | 0.20   |
| CZ    | 10    | 4.47  | 1.45 | 2.33  | 6.00  | -0.91  |
| GB    | 10    | 3.93  | 0.97 | 2.33  | 5.33  | -0.65  |
| AU    | 10    | 3.70  | 0.96 | 2.33  | 5.67  | -0.20  |
| UU    | 10    | 3.70  | 1.64 | 0.67  | 5.67  | -1.79  |
| MG    | 10    | 2.87  | 1.96 | 0.33  | 5.67  | -1.49  |
| TOT_K | 10    | 22.57 | 6.18 | 14.67 | 32.67 | -1.14  |

Legend: ZD-Zenkutsu dachi, CZ-Choku zuki, GB-Gedan barai, AU-Age uke, UU-Ude uke, MG-Mae geri, TOT\_K-Total karate skills.

Table 4 contains the results of a linear correlation analysis which identifies the relation between the fundamental motor and specific karate skills. The values from the first column are the most interesting. When observing the karate skills separately, all of them are significantly positively correlated with the fundamental motor skills results. All specific skills included, the highest correlation was found between the TGMD-2 and the *mae geri* kick (0.68). If we focus on total karate skills, we find the highest positive correlation with the fundamental motor skills (0.74), as expected.

This relation can also be observed in Figure 1, where fundamental motor skills increase follows the increase of specific karate skills.

Table 4: Correlation between fundamental motor skills (TGMD) and specific (ZD, CZ, GB, AU, UU, MG) and total (UK\_K) karate skills.

|       | TGMD | ZD   | CZ   | GB   | AU   | UU   | MG   | TOT  |
|-------|------|------|------|------|------|------|------|------|
| TGMD  | 1.00 |      |      |      |      |      |      |      |
| ZD    | 0.57 | 1.00 |      |      |      |      |      |      |
| CZ    | 0.51 | 0.65 | 1.00 |      |      |      |      |      |
| GB    | 0.61 | 0.42 | 0.60 | 1.00 |      |      |      |      |
| AU    | 0.51 | 0.59 | 0.57 | 0.36 | 1.00 |      |      |      |
| UU    | 0.62 | 0.59 | 0.58 | 0.48 | 0.50 | 1.00 |      |      |
| MG    | 0.68 | 0.56 | 0.55 | 0.59 | 0.61 | 0.79 | 1.00 |      |
| TOT_K | 0.74 | 0.77 | 0.81 | 0.73 | 0.73 | 0.85 | 0.88 | 1.00 |

Legend: ZD-Zenkutsu dachi, CZ-Choku zuki, GB-Gedan barai, AU-Age uke, UU-Ude uke, MG-Mae geri, TOT\_K-Total karate skills.

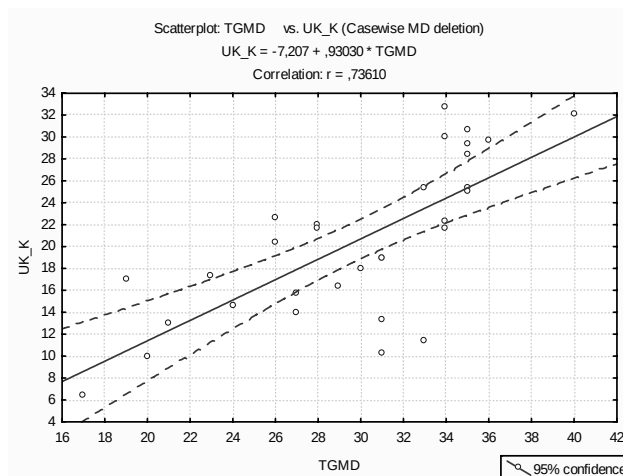


Figure 1: Correlation between fundamental motor skills (TGMD) and total karate skills (TOT\_K)

## Discussion and conclusions

According to the high values of Cronbach alpha coefficients in all tests we can conclude that the judges were objective. To determine the characteristics of the distributions and sensitivity Kolmogorov-Smirnov test was used. It revealed that all tests of specific karate skills, as the TGMD-2, have normal distributions and, therefore, are sensitive. As expected, factor analysis of six specific karate skills resulted in one factor extraction – karate skills factor. It is obvious that the highest projection has the *mae geri* kick while the other tests' projections are smaller but still significant. For this research purposes it can be concluded that the test are valid and that they measure what constructed for: karate skills. Similar results between boys and girls in fundamental motor skills confirm previous researches (Mazzardo, 2008; Simons, Daly, Theodorou, Caron, Simons & Andoniadou, 2007). Girls, however, dominate in the area of specific karate skills but with no significant difference. These results allowed us to consider the boys and the girls as a unique sample.

Karate skills are significantly positively correlated with the fundamental motor skills results. In other words, those children with higher level of fundamental motor skills also have a better karate technique, while others have difficulties in karate technique acquisition. Burton & Miller (1998) define specific motor skills as a combination or different manifestations of one or more fundamental motor skills. However, they believe that in order to learn specific skills, fundamental motor skills do not need to reach a certain level. They interpret that with a fact that a child in the age of 2, for example, can acquire a certain specific skill, like skating or rolling, although its fundamental motor skills haven't reached an optimal level yet.

A different situation occurs in children age 5 to 7, who are in the last stage of fundamental motor skills development (Gallahue & Donnelly, 2003), and have a higher level of motor proficiency and, therefore, a more coordinated and accurate movement patterns. In this stage combining fundamental motor skills with motor abilities can result in a useful application for learning a large amount of specific skills. So, motor programs in the age of 2 and 5 are completely different and cannot be compared because of a different development stage and different relations between the fundamental and specific skills. The highest correlation occurred in *mae geri* kick.

This probably because the mentioned skill is the most complicated technique for preschool children and it is clear those children with higher motor proficiency will perform better. Statistically significant correlation has also been determined between fundamental motor skills and total karate skills. That was the evidence of an assumption that children with higher fundamental skills learn the specific skills faster, easier and on a higher level. This correlation enables more appropriate selection process and the beginners training process organization with the aim of fundamental motor skills quality development which is the basis of specific karate technique learning in later stages. Results gained with this study are entirely in accordance with prior research in the area of motor skills. It is logical to conclude that specialized skills are nothing but a combination of different fundamental motor skills applied on the performance of a certain sport discipline. So, the correlation that was gained was expected, however, different combinations of those skills are the factors that differentiate successful athletes from those that are less successful. For better understanding of fundamental and specific skills relations long-term monitoring (longitudinal studies) is necessary. Also, physical activity and inactivity are the parameters that cannot be avoided since they are very important moderators of children's motor development.

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## RELACIJE IZMEĐU TEMELJNIH MOTORIČKIH VJEŠTINA I SPECIFIČNE KARATE TEHNIKE KOD POČETNIKA UZRASTA 5 – 7 GODINA

### Sažetak

Cilja ovog istraživanja je bio da se utvrde moguće povezanosti temeljnih motoričkih dimenzija i specifičnih karate vještina djece uzrasta 5 do 7 godina. Ukupno je 31 dijete (21 dječak i 10 djevojčica) sudjelovalo u ovom istraživanju i mjerenju u dvije testne sesije: temeljne motoričke dimenzije i specifične karate vještine. Temeljne motoričke dimenzije su procjenjivane korištenjem najšestije primjenjivanog testa – TGMD-2. Tri neovisna ocjenjivača vrednovali su izvođenje šest specifičnih karate elemenata gledanjem snimljenog materijala. Prema visokim vrijednostima Cronbach alfa koeficijentata (0.91-0.98), Kolmogorov-Smirnovljevog testa i rezultata faktorske analize može se zaključiti da su specifični karate testovi validne mjere za djecu uzrasta 5 do 7 godina. Također, nepostojanje značajnih razlika između dječaka i djevojčica potvrdilo je pethodna istraživanja u prostoru temeljnih motoričkih dimenzija. Oni se značajno ne razlikuju ni u specifičnim karate vještinama. Karate vještine su značajno pozitivno korelirane s temeljnim motoričkim dimenzijama (0.74). Ova korelacija omogućava odgovarajući proces selekcije kao i organizaciju trenažnog procesa početnika pri čemu je cilj kvalitetan razvoj temeljnih motoričkih dimenzija koji predstavlja bazu za učenje specifične karate tehnike u kasnijim razdobljima.

**Key words:** predškolci, borilačke vještine, TGMD-2, motoričko znanje

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## EDUCATIONAL ASPECT OF MICRO-SOCIOLOGICAL STRUCTURING IN GRAMMAR SCHOOL POPULATION

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### **Abstract**

*The aim of the research is to define educational aspect of micro-sociological structuring among Grammar school female population in order to recognize relevant variable dynamic relations which will lead to conclusions and accordingly propose appropriate suggestions. In order to solve the problem we used sample of 647 girls from the first to the fourth grade of Grammar school, described through 16 variables of micro sociological structure and 4 variables from field of education. Data were gathered through survey. After normalization, canonic correlation analysis was conducted in order to determine linear combinations of two sets of variables. Obtained results indicate existence of one canonic factor which contains two groups of different intensity indicators where the group with larger intensity aims toward ethical values and the group with smaller intensity are aimed at competent decision making. We can conclude that population recognizes the essence of education as the system of values but with the necessity of the existence of a competent decision-making as the ultimate goal.*

**Key words:** *female students, education, structure, micro-sociology, analysis, decision making, values*

### **Introduction**

System of values of each society is the essence, the core of its social culture which makes it different from other societies and it is essential to pass it to new generations in order for society to survive and progress. Those values are passed through socialization, education especially during primary education in family and secondary education in school, sport clubs etc. (Fanuko, 1995; Haralambos & Heald, 1989). These days, media, TV, internet etc. educate members of society one way or another. Their role is obvious in Western countries where media is considered as "the fourth class of society" (Lorimer, 1998).

System in any human community is functioning according to certain rules and each individual has its own role and preparing these individuals to accept their sociological responsibilities becomes major issue (Petrović & Hošek, 1986). Many understandings prove it is necessary to include all essential elements of social communities (Greene, 2007; Morris & Burford, 2007). Time is the most creative constructor. Over time the values are developed, shaped and complemented making society more developed, more complex and generally more stable. It is obvious that the method of passing these values has to be appropriate and adjusted to the needs of certain society, has to be extremely sophisticated and there must be an opportunity for its development. This means that this method has to change over time. In order to accept the values through socialization process, one has to learn – discover, has to endure relatively permanent changes. These changes are the result of his psychological activity. All this will enable changes of behavior in situations that require these changes. This can be accidental.

However, the process of transferring value requires organized and deliberate motive learning, in other words education and organized and deliberate learning of cognitive and psychomotor personality (Wilson & Schwier, 2009). The conclusion would be that a man needs education, an organized education, and the most organized education is through the system of schooling (Pastuović, 1999).

Officially, that is the time when a human being is studying, doing it in appropriate institutions which include curriculum, regulations etc., in accordance with Constitution and the Law and according to predetermined and society required regulations but learning does not start with institutions. Various research confirm that a child was not born as "tabula rasa" but starts its learning during prenatal period, practically since birth and then continues to learn for the rest of its life (Smajlović, Bonacin & Bonacin, 2007; Bonacin, Da., 2008). However, all intervals in human's life have its importance rules and preferences. Each of these intervals is crucial for individual in proportion to the level of its current location (Bruce, 1980; Borić et al., 2008; Bognar, 2009). But the interval which finally shapes individual as an adult is "High school". During this interval, individual is seeking for its identity, identifies itself and develops its attitude. At the same time it forms the way of thinking which will characterize him as a person, in most cases for entire life (Stolte et al., 2001; Abbot-Chapman et al., 2007; Alston, 2009). In such complex and variable phase, the unit is integrated into society, inevitably joining a particular clique (Bonacin, Bilić & Bonacin, 2008) formed within microstructure of its environment constantly learning the rules of society it lives in (Buljubašić-Kuzmanović, 2007).

For that reason it is interesting to study the relations of educational aspects, therefore effects of institutionalized and organized high school education with segments of micro-sociological structure i.e. cliques formed by the same population in the same time. This is extremely interesting when it comes to female population.

### Subject, problem and goal

Regardless where we start our research, the conclusion will be the same; High school, especially second grade of high school has essential role in forming attitudes, way of thinking and habits of students (Bilić, 2009). Logical conclusion would be that the future individual depends on the quality and stability of development, therefore primarily education in this period. This is particularly true for females. For this reason we chose female students from Grammar school in Herzegovina as the subject for this research. Problem of this work is determining relations between educational aspect and micro-sociological structure which is formed in a shape of cliques during this period. The aim of this work is to recognize dynamic relations of relevant variables in order to offer conclusions and accordingly give suggestions for improvement of educational process.

### Methods

For this research we used sample of entities that included 647 girls from the first to the fifth grade of Grammar school (167 + 158 + 166 + 156) in Herzegovina described with micro-sociological area variables ( *the rules always depend on the same group of people who are making decisions; they are stable and independent, people who control institutions are politically very active; people who make decisions tend to agreements; I think I would lead some institutions better, we should start to make some decisions; it is easy to organize group that would better manage institutions and people, opposition has a greater impact on people then government, during decision making the best is to stay on the side, when you are not in the centre of event it is easier to perceive the problem; the real man is individual and does not have to put an effort in the group; many, if not everyone, like me and that is the best way to be; I set goals well in my life and try my best to achieve them; each method is good if it leads you to your goal; capable manager finds his interest in everything; we have to manage people, things and events in our surrounding.*).

Four variables of socialization subsystem as well ( *education degree today is less important than before; everyone need education regardless age, gender, religion; learning is an important aspect of education in process of transferring society values; better education opens opportunity for better working positions.* ). Data were gathered through survey (author Da. Bonacin) and each statement is marked with 5 models from "I do not agree" to "I completely agree".

After category data classification, classic canonical correlation analysis was applied in order to determine linear combinations of two sets of variables. The results pointed to the existence of one canonical factor with average canonical coefficient (0,32), where one group of indicators has **higher intensity**; *When you are not in the centre of event it is easier to perceive the problem, (0,45), each method is good if it leads you to your goal (-0,53), we have to manage people, things and events in our surroundings (-0,41), everyone needs education regardless age, gender and religion ... (0,75), learning is an important aspect of education of transferring social value (0,61).*

The second group of indicators points to **lower intensity**; *the rules always depend on the same group of people who are making decisions (0,38); decisions makers are stable and independent, (-0,26); people who control institutions are politically very active (0,35); we should start to make some decisions (0,23); it is easy to organize group that would better manage institutions and people (-0,24); during decision making the best is to stay on the side (-0,15); the real man is individual and does not have to put an effort in the group; (-0,25); I set goals well in my life and try my best to achieve them (0,24); education degree today is less important than before (-0,35); better education opens opportunity for better working positions (-0,17).* According to previous results we can conclude that measured female population considers that not every method of achieving your goals is good, we should not manage people and the problems are better perceived when observed from the side. According to them education should be available for everyone as a system of values and they think learning is important aspect of transferring society values (Collins, 1988).

Therefore, the essence of their thinking lies in ethical value system as the goal of education. On the other hand, respondents understand that few people make decisions with political activity, but also that those people can be unstable and dependent. The ones who control the situation have to be very active politically. They agree that a part of decision making should be accepted but they think it is not easy to organize the group that could better manage institutions and people. Furthermore, they understand when making decisions it is not good to stay on the side, that they should participate and put effort into the group. They consider that they determine their goals well in their life and they try their best to achieve them and also think the degree of education matters like before but not necessarily opens opportunity for a better working position. They think decision making has to be competent. Therefore, the tested population sees education as a value system with the ultimate goal of competent decision making.

## Results

Table 1. Canonical correlation analysis and significance testing

|                       |                       |                                                                                                |              |
|-----------------------|-----------------------|------------------------------------------------------------------------------------------------|--------------|
| Micro-soc. indicators | Functional clique     | The rules always depend on the same group of people who are <i>making decisions</i> .          | 0,38         |
|                       |                       | People who impact the rules are stable and independent.                                        | -0,26        |
|                       |                       | People who control institutions are politically very active.                                   | 0,35         |
|                       |                       | People who make decisions tend to agreements.                                                  | 0,09         |
|                       | Opposite Clique       | I think I would manage some institutions better.                                               | 0,08         |
|                       |                       | We should start to make some decisions.                                                        | 0,23         |
|                       |                       | It is easy to organize group that would better manage institutions and <i>people</i> .         | -0,24        |
|                       |                       | Opposition has a greater impact on people then government.                                     | -0,09        |
|                       | Regulative Clique     | During decision making the best is to stay on the side.                                        | -0,15        |
|                       |                       | When you are not in the centre of event it is easier to perceive the <i>problem</i> .          | <b>0,46</b>  |
|                       |                       | The real man is individual and does not have to put an effort in the group.                    | -0,25        |
|                       |                       | Many, if not everyone, like me and that is the best way to be.                                 | -0,03        |
|                       | Management tendencies | I set goals well in my life and try my best to achieve them.                                   | 0,24         |
|                       |                       | Each method is good if it leads you to your goal.                                              | <b>-0,53</b> |
|                       |                       | Capable manager finds his interest in everything.                                              | 0,07         |
|                       |                       | We have to manage people, things and events in our surrounding.                                | <b>-0,41</b> |
| Socialization         | Education             | Education degree today is less important than before.                                          | -0,35        |
|                       |                       | Everyone needs education regardless age, gender, religion.                                     | <b>0,75</b>  |
|                       |                       | Learning is an important aspect of education in process of transferring <i>society value</i> . | <b>0,61</b>  |
|                       |                       | Better education opens opportunity for better working positions.                               | -0,17        |

| Root | RO  | Hi <sup>2</sup> | DF | W   | p           |
|------|-----|-----------------|----|-----|-------------|
| 1    | .32 | 109.39          | 64 | .84 | <b>.001</b> |
| 2    | .21 | 42.52           | 45 | .94 | .577        |
| 3    | .11 | 14.04           | 28 | .98 | .986        |
| 4    | .10 | 5.83            | 13 | .99 | .952        |

(Root = extracted canonical root, RO = multiple correlation, Hi<sup>2</sup> = hi-square test, DF = degrees of freedom, W = Wilks lambda, p = probability)

## Discussion and conclusion

We cannot say that society has ever been simple. But society today is more than complex, since it is primarily extremely loaded with numerous recent scientific results, i.e. technological achievements, daily loaded with more or less important information, overpopulated. With greater needs and modern era globally, in connection with other societies and their cultures, this leads to each of the segments mentioned above.

Education today actually becomes more than just a transfer of system of values. It becomes guardian of its own value at the same time when its cultural sphere communicates information about values of other societies. A phenomenon of multicultural education becomes essential where social conflicts are resolved with wars between nations. Then the crisis of the multicultural education may be a component of both the causes and consequences of social conflicts (Hechter & Satoshi, 1997; Holden 2001). So the education in multicultural society is imperative of current and future time, assumption of true personal and social progress, component of humanistic civilization (Goffman, 1983; Fine, 1991; Sewell, 1992; Lareau, 2002; Ivanović, 2009; Phillips & Smith, 2010). For that reason it is necessary to elevate above the traditional boundaries of sociological research and integrate research in various areas, pedagogy through communication to sociological psychology and emotions in order to research micro-world of one's thoughts, feelings and nature (Scheff, 1990) and accordingly improve educational process.

Those sudden and rapid changes that are happening on daily basis in modern society have influenced the need for paradigm in the organization of teaching process. Contemporary concept of education requires a focus on students as the subject of educational process, focus on multiplicity and variety of content choice and teaching students' methods and strategies of independent learning as a necessary assumption of lifelong education. Modern generations have adopted their knowledge from the television and computer, and they structured their way of thinking according to these sources, therefore require a different newer way of teaching that is in accordance with their mental functioning (Johannessen, 1997; Nagel & Kvernbeek, 1997; Maines, 2001; Kay et al., 2009; Maylone, 2009). The task of society and the education system as its representative to created the conditions for such an organization of teaching process – from material and technical, professional methodical, related to education of teachers to work in modern conditions (Arbunić & Kostović-Vranješ, 2007). Since the development of education is aimed toward learning process of gaining basic knowledge, capability of solving problems, preparing for new challenges in the future and developing skills of students, it is obvious that the future society has to become a learning society. This means education will actually be a life-long learning, which is, according to some authors, a direct consequence of globalization and international development of politics (Vidulin-Orbanić, 2007).

Thereby we forget that a man is born to learn and discover, which is basic condition of his existence and development, therefore the globalization is only process that elevated this knowledge to a higher level. It was not caused by international politics it was just finger-pointing in the existing segments of human existence. Considering that the basic meaning of educational and training activity is pedagogical relationship, in other words relationship between educator and the student, besides what is being transferred (system of values) and how is this transferred (education) very important role in the educational system has a personality of educator and its necessary to improve conditions for their qualifying, education and their financial and social status in educational system (Čatić & Stevanović, 2003; Lučić, 2007). At the same time we must not forget that the competitiveness of enterprises and institutions, and therefore the school, in a modern society depend on the knowledge and professionalism of the teachers which is the reason for their continuous development and they are also aware of that (Gobo, 2008). A place where we recruit potential future educators is the same place where the respondents from this work are from. Exactly during this time they are going through adolescence, a crucial moment of their life which includes all physical and psychological changes from childhood to mature, where sexual maturity and establishing relations to other sex have essential role (Đorđević, 1978). During this period they form attitude and opinion that shapes them as sensible, individual and separate being, different from the others, but in order to form that attitudes they have to have maximum access to information, knowledge about importance of cognition and at last the desire for absorbing knowledge. However, adolescents are still in the midst of a multitude and diversity of information, but with poor information they are afraid of their future and therefore they are uneasy (Collins, 2009). It is doubtful how much current pluralistic society is helping (Ninčević, 2009). Therefore, what is natural and normal is the greatest challenge: creation of identity.

Nevertheless, several previous studies established that the high school population in second year of school is passing through crisis period after which it already has an opinion and attitude about most things and they are not afraid to say it in public. In most cases they defend their opinions, mostly understand the true importance of education, positive and negative sides of teaching process, and at least roughly know what they would change. However, within the structure of the examined population the intensity is on the essence that is the aim of education i.e. ethical values, while the lower intensity is on criticism (Small & Dickie, 1999; Snauwaert, 2009). They are not careless when achieving goals, they are aware of ambition importance and team work and other characteristics and complex conditions that have to be followed by the ones who make decisions and they are cautious regarding this. They are aware that education transfers values and how important that is, but they are not selfish, they also think everyone needs education. They also know that education by itself cannot guarantee certain things in life but is an excellent basis for further work and success.

Each individual when "out in the world", following natural tendencies throughout micro-sociological structuring joins and can be recognized in one of three cliques; **functional** the strongest subgroup with obvious tendency of gaining and keeping control, **opposite**, weaker subgroup with obvious tendency of taking control and **regulative**, subgroup with tendency to evade between previous two depending on the variation of results (Paranosić & Lazarević, 1975; Momirović 1984; Bonacin, Bilić, Bonacin, 2008). Who will join which clique depends mostly on its personality traits and knowledge that they adapt to that moment. Consequently, that is how the future society of this generation will be structured. From all apparent, the exceptional importance is to establish relations of educational aspect and micro-sociological structuring of the population of this age (Cook & Whitmeyer, 1992; da Silva & Meucci, 2010).

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## EDUKACIJSKI ASPEKT MIKROSOCIOLOŠKOG STRUKTURIRANJA U POPULACIJI SREDNJOŠKOLKI

### Sažetak

Problem rada je definiranje edukacijskog aspekta mikrosociološkog strukturiranja u populaciji srednjoškolki a u cilju prepoznavanja dinamičkih relacija relevantnih varijabli kako bi se donijeli zaključci te shodno tome i ponudili adekvatni prijedlozi. Za potrebe rješavanja problema korišten je uzorak entiteta od 647 djevojaka od prvog do četvrtog razreda gimnazije, opisan sa 16 varijabli strukture mikrosociološkog prostora i 4 varijable iz prostora edukacije. Podaci su prikupljeni anketom. Nakon normalizacije izvršena je klasična kanonička korelacijska analiza kako bi se utvrdile linearne kombinacije između dva skupa varijabli. Dobiveni rezultati pokazuju postojanje jednog kanoničkog faktora koji u sebi sadrži dvije grupe indikatora različitog intenziteta pri čemu je grupa indikatora s višim intenzitetom usmjerena na etičke vrijednosti, a grupa s nižim intenzitetom usmjerena na kompetentno odlučivanje. Za zaključiti je da populacija suštinu obrazovanja vidi kao sustav vrijednosti ali uz nužnost postojanja kompetentnog odlučivanja kao krajnjeg cilja.

**Ključne riječi:** gimnazijalke, edukacija, struktura, mikrosociologija, analiza, odlučivanje, vrijednosti

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## MORPHOLOGICAL AND MOTOR DIMENSIONS OF YOUNG BASKETBALL PLAYERS

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### Abstract

*Among modern team sports, basketball is one the most popular sports in the world, but in nowadays it is getting to be popular even in our country. By considering the dynamics of the game and being aware of the obstacles that the basketball players can face, it will require a proper motive for a physical and tactical preparation. Performing the experimental results with a certain number of variables, it will provide us with data, which will define the anthropological status of young people. In such sense, by means of set of variables, using factor analysis, we have isolated two motor and three morphological factors described as: 1) complex motor factor, 2) explosiveness of upper part of body, and 1) general factor of growth, 2) longitudinal growth, 3) physical body capacity. We realize presumption that this information could be used for aims of selection and transformation processes programming with young sportsman.*

**Key words:** *basketball, motor dimensions, morphology*

### Introduction and aim

Among modern team sports, basketball is one of the most popular sports in the world, but in nowadays it is getting to be popular even in our country. Considering the dynamics of the game and being aware of the obstacles that the basketball players can face, it will require a proper motive for physical and tactical preparation. Realizing the experimental results with a certain number of variables, it will provide us with data, which will define the anthropological status of young people.

The aim of this experiment is revealing some relevant morphological, motor and specific characteristics among young basketball players. In other words, the objective of this study can be defined as verifying the values of some morphological characteristics and at the same time verifying some motor and specific characteristic among young basketball players.

### Methods

The experiment covers 66 entities of young males, approximately 16 years old, who have been practicing basketball in the city of Pristine. The testing was conducted during November and December of 2009. Furthermore, the morphological tests were conducted during the morning hours, whereas the motor tests were conducted during the basketball practice time. The author of this study should be able to demonstrate appropriately in order to make sure that students understand the tests in the best way. All tests were conducted in the sports center and included all primary schools in Pristine. Considering the previous studies, the actual hypotheses is based on the existence of factors and its connections at the morphological, motor, basic and specific level among young basketball players in morphological and motor area.

### Variable and Data processing

In order to set the morphological field, 10 tests were applied as follows: BOWE - body weight BOHE - body height, HALE - hand length, LELE - leg length, FOLE - foot length, PALE - palm length, PAWI - palm width, ARPE - arm perimeter, THIPE - thigh perimeter, FEPE - femur perimeter. In the motor field, 10 tests were applied, five of them were basic tests and the other five situation tests as follows: JFMSPD - The jump from the spot to a distance, JFMSh - The jump from the spot to a highness, 20 MRU - The 20 meters running, TFPHSSM - The test for the physical strength of the stomach muscles, THMBD - Throwing the medicine ball in a distance, DBHC - Dribble by hitting in the cage, FRHI - Free hitting, HICWJ - Hitting the cage with a jump, THBID - Throwing the ball in a distance, GOCOD - dribbling back and forth. The results are elaborated in SPSS version 16,0 with the factorization.

### Results

#### Morphology field

Table. 1. Relevant eigen values

| No. | Eigen | %     | % cum  |
|-----|-------|-------|--------|
| 1   | 5.155 | 51.55 | 51.552 |
| 2   | 1.673 | 16.73 | 68.283 |

Table 2. Principal components and communalities

|       | 1   | 2    | H <sup>2</sup> |
|-------|-----|------|----------------|
| BOHE  | .87 | -.32 | .85            |
| BOWE  | .87 | .25  | .81            |
| HALE  | .77 | -.39 | .75            |
| LELE  | .79 | -.36 | .75            |
| FOLE  | .62 | -.40 | .54            |
| PALE  | .53 | -.25 | .35            |
| PAWI  | .72 | -.11 | .53            |
| ARPE  | .60 | .61  | .73            |
| THIPE | .62 | .64  | .80            |
| FEPE  | .72 | .46  | .73            |

Table 3. Parallel projections

|       | 1    | 2    |
|-------|------|------|
| BOHE  | .88  | .08  |
| BOWE  | .41  | .65  |
| HALE  | .88  | -.03 |
| LELE  | .87  | .00  |
| FOLE  | .77  | -.11 |
| PALE  | .59  | -.01 |
| PAWI  | .61  | .22  |
| ARPE  | -.08 | .89  |
| THIPE | -.09 | .92  |
| FEPE  | .14  | .79  |

Table 4. The matrix of the orthogonal projections

|       | 1   | 2   |
|-------|-----|-----|
| BOHE  | .92 | .45 |
| BOWE  | .68 | .82 |
| HALE  | .87 | .33 |
| LELE  | .87 | .36 |
| FOLE  | .73 | .21 |
| PALE  | .59 | .24 |
| PAWI  | .70 | .47 |
| ARPE  | .29 | .85 |
| THIPE | .30 | .89 |
| FEPE  | .46 | .85 |

Table 5. Correlations between factors

|   | 1    | 2    |
|---|------|------|
| 1 | 1.00 |      |
| 2 | .41  | 1.00 |

### Motor area

Table 6. Relevant eigen values

| No. | Eigen | %     | % cum |
|-----|-------|-------|-------|
| 1   | 3.46  | 34.56 | 34.56 |
| 2   | 1.45  | 14.45 | 49.01 |
| 3   | 1.05  | 10.54 | 59.56 |

Table 7. Principal components and communalities

|         | 1    | 2    | 3    | H <sup>2</sup> |
|---------|------|------|------|----------------|
| JFMSPD  | .74  | -.22 | -.10 | .61            |
| JFMSH   | .76  | -.06 | -.22 | .64            |
| 20 MRU  | -.63 | .49  | .21  | .68            |
| TFPHSSM | .48  | .70  | -.02 | .72            |
| THMBD   | .39  | .74  | -.11 | .71            |
| DBHC    | .68  | -.16 | -.05 | .50            |
| FRHI    | -.69 | .08  | .09  | .49            |
| HICWJ   | .26  | .02  | .77  | .66            |
| THBID   | .40  | -.19 | .55  | .50            |
| GOCOD   | -.62 | -.21 | -.17 | .46            |

Table 8. Parallel projections

|         | 1    | 2    | 3    |
|---------|------|------|------|
| JFMSPD  | .76  | .01  | .05  |
| JFMSH   | .75  | .19  | -.08 |
| 20 MRU  | -.86 | .28  | .07  |
| TFPHSSM | .03  | .84  | .02  |
| THMBD   | -.01 | .86  | -.09 |
| DBHC    | .66  | .05  | .09  |
| FRHI    | -.64 | -.14 | -.04 |
| HICWJ   | -.15 | .04  | .84  |
| THBID   | .17  | -.11 | .65  |
| GOCOD   | -.32 | -.38 | -.27 |

Table 9. The matrix of the orthogonal projections

|         | 1    | 2    | 3    |
|---------|------|------|------|
| JFMSPD  | .78  | .20  | .26  |
| JFMSH   | .77  | .36  | .15  |
| 20 MRU  | -.78 | .08  | -.13 |
| TFPHSSM | .24  | .85  | .15  |
| THMBD   | .16  | .84  | .02  |
| DBHC    | .70  | .22  | .28  |
| FRHI    | -.69 | -.30 | -.24 |
| HICWJ   | .09  | .12  | .80  |
| THBID   | .33  | .02  | .68  |
| GOCOD   | -.49 | -.50 | -.42 |

Table 10. Correlations between factors

|   | 1    | 2    | 3    |
|---|------|------|------|
| 1 | 1.00 |      |      |
| 2 | .24  | 1.00 |      |
| 3 | .28  | .14  | 1.00 |

### Discussion and conclusion

As far as the 6th table is concerned, there are obvious LAMBDA radices and partial % and cumulative % contribution for the explanation of the variability in general. By choosing the correlative matrix, we win 10 characteristic radices and the same number of characteristic vectors which, according to Hotelling method and GK criteria, are presented as three motor and latent dimensions which explains the 6% variability in general. Considering the first and statistic matrix of the factorization of the motor tests, we can notice that the first characteristic radix with the value  $L=3.456$ , explains 34.5% of the variability in general, and the second characteristic radix for the system with the value  $L=1.445$  and explains the 14.4% of the variability in general. The third characteristic radix for the system with the value  $L=1.054$  and explains the 10.5% of the variability in general. Through the table 7, it contains the matrix of the main components with three factors and communalities. In the first component were projected variables which test the explosive strength of the lower body part such as, jumping from a certain place to a distance, jumping from a spot to a highness, and the 20 meter running with coefficient from .63 - .76.

Then, we conducted tests that show repetitive strength with coefficient .68, and tests that show specific speed during the basketball play. After that applied the dribble with hitting the cage and dribbling back and forth, the tests which show resistance in the speed with coefficient that have value from -.62 to -.69. On the second component the tests are projected, which show the explosive strength of the upper part of the body by throwing medicine ball and throwing the basketball to a distance with a coefficient from .70 to 7.4. On the third component, the projections are realized through the tests, which show accuracy in the area of free hitting and hitting through the jump with the coefficient from .55 to 77. Collectiveness towards all tests have the coefficient with the value .46 to .72, but how much qualitative information will bring each variables, it depends on the volume of collectiveness. In the structure of the motor areas, the main components are projected in the inclined solutions, rotations, and according to the normalization of the criteria (Kaiser-it) and these transformations came up with three matrixes:

- The matrix of the parallel projections, which shows parallel projections of the variable vectors to factors.
- The matrix of the orthogonal projections, which shows the correlative and orthogonal projections between variable vectors and factors.

The correlation matrix of isolated factors is interesting. As presented in table 8, there is matrix of parallel projections, which covers the parallel projection of the motor variables. By observing this matrix we notice that high projections on the first factor have realized the following tests, jumping from a certain place to a distance, jumping from a certain place to a highness, the 20 meter running, which show the explosive strength of the lower part of the body with coefficient starting from .75 to .86. Moreover, we have the tests NTKMB and the dribble with hitting the cage which shows the specific speed during the basketball game with coefficient that has the value starting from -.64 to .66. According to these projections, the first motor factor can be defined as a **complex and motor factor**.

On the second component, the high projections have been realized by the tests, which show explosive strength of the upper part of the body such as, throwing the medicinal ball, throwing the ball in a distance with coefficient from .83-.85. According to the projections presented here, the second factor could be defined as a **factor with an explosive force of the upper part of the body**. On the third component, high projections have realized the tests which are as a pointer of the preciseness such as, free hitting, hitting through jumping with coefficient that has the value .65 to .84. According to these projections, the third factor can be defined as a motor and situated factor of the variability –very typical for the basketball game.

Concerning the table 9, the orthogonal projections are presented, which contain orthogonal projections of the manifest - motor tests, and as a result, we have three factors. According to all predictions, the structure of this matrix does not change from the parallel projections.

On the table 10, it is shown the correlative matrix of the motor factors and we can notice that the correlation of the factors is with coefficient from .14 to .28. According to this correlation, we can conclude that motor factors depend on each other.

In the first table are exposed the characteristic radices LAMDA and the partial % and cumulative % contribution for explaining the differences in general. The characteristic radices are ranked according to the size, which in other words shows the ranking of the latent aspect. According to Hotelling and Kaiser, it has been extracted two latent dimensions, which explain the 68% of the general variable. The first characteristic radix explains the 51% of the general variable and the second radix of the system explains the 17% of the general variable. In the second table, it is presented the matrix of main components with two factors and the communalities of the morphological tests. In the first main component, all morphological tests have realized projections with high value from .53-.86, so the body weight and height realize projections with higher value than .86. The first component with 51% of the general variable system includes the characteristics of the **general factor for growing and developing** normally as far as youth is concerned. On the second component with characteristic radices like,  $L = 1.673$  and partial contribution of 17%, we have relevant projections with bipolar character, especially the tests which show us the length such as, body height, hand length, leg length, foot length, and palm length. All these can be projected in the positive pole with coefficient value of .24 to .40. The test that measures the circulative dimensions such as, the arm, thigh and cartilage perimeter, will project in the negative pole with coefficient from .47 to .64. Moreover, the communalities have the value for the all tests with coefficient from .52 to .85, where each variable depends on the communality size and how it will present valuable information.

The major significance for the right interpretation of the factors it is up to the matrix of the parallel projections. In table 3, it can be noticed that high projections have realized tests, which define the **longitudinal growth** of the skeleton such as, the body height, hand length, palm length, leg length, foot length, and palm width with coefficient starting from .59-.88. Otherwise, this factor can be defined as the factor of longitudinal and transversal dimension of the human skeleton. Concerning the third factor, high projections have been realized by the tests, which measure the circular dimension such as, the arm perimeter, thigh perimeter, cartilage perimeter, and body weight with coefficient starting from .65.

Differently, this factor can be defined as, **the factor of body weight and capacity**. As far as the forth table is concerned, the matrix of the orthogonal projections includes orthogonal projection of the morphological tests and as a result we have two factors. The structure of this matrix does not differ that much from the parallel projections. According to the inter correlation of the latent factors, the first factor with the second factor have important correlation with coefficient .41, which results in a way that we can conclude the presence of the general factor for the development and growth of the youth.

The main components serve mostly as a coordinative system for the vectors of the correlative matrix of the variables because usually it happens for them not to be interpreted as they really are. Therefore, in order to explain clearly the latent aspect, the main components transform in the aslant solutions and as a result, we have three matrixes. Taking into consideration this experiment, there are two hypotheses: The first hypothesis is realized completely and according to the results, there have been extracted two latent and morphological dimensions. The second hypothesis is also realized completely, where according to the results, there have been extracted three latent dimensions in the specific, basic and motor area. According to the 66 entities, of 16 years old males, it has been realized the morphological aspect of consisting 10 tests, and the motor aspect consisting 10 tests.

Based on the factorial procedure, all morphological, motor and specific tests were applied and as a result, we got five latent dimensions: factor of the transversal dimensionality, capacity and volume of the skeleton, factor of the explosive force and longitudinal dimensionality of the skeleton. In motor area: factor of accuracy and specific speed, complex, motor, situated and typical factor of the basketball game, factor of the speed and explosive strength of the upper extremities. The interference or mixing of factors can be excused because of the age we consider since it is the age of puberty where nothing is determined on the level of morphology or motor dimensions. The function of the result is about: Securing the information about the youth and their development of the morphological and motor characteristics. The aim is to expose the values of the educational process during the teaching process concerning the physical education and sport. The number of the practice classes should be increased and compensated for other motor activities. This should help selection and orientation of the youth in different sport activities as well as application of the new concepts in terms of scientific and professional bases of the program, methodology and adequate evaluation.

On the bases of realizing the results and values, there is the need for further research and discovery of other relevant factors, which will directly influence this experiment and will serve for the best of the society. This experiment opens new perspectives in the future.

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## MORFOLOŠKE I MOTORIČKE DIMENZIJE MLADIH KOŠARKAŠA

### Sažetak

*Među modernim sportskim igrama, košarka je jedan od najpopularnijih sportova u cijelom svijetu, ali danas postaje sve popularnija i u našim krajevima. Uvažavajući dinamiku igre i ometanje s kojim se igrač može susresti u igri, zahtijeva se odgovarajući motiv za kondicijsku i taktičku pripremu. Istražujući rezultate eksperimentalnog programa uz pomoć brojnih varijabli koje su nam osigurale informacije, moguće je definirati dio antropološkog statusa mladih sportaša. U tom smislu, u skupu varijabli, faktorskom analizom, izolirana su dva motorička i tri morfološka faktora opisana kao: 1) složeni motorički faktor, 2) eksplozivnost ruku i ramenog pojasa, te 1) opći faktor rasta, 2) longitudinalni rast, i 3) tjelesni morfološki kapacitet. Pretpostavljeno je da ove informacije mogu poslužiti u svrhu selekcije i programiranja transformacijskih procesa s mladima.*

**Ključne riječi:** košarka, motoričke dimenzije, morfologija

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**INTERNATIONAL BASKETBALL ACTIVITY IN THE KINGDOM OF YUGOSLAVIA**

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*Review paper*

**Abstract**

*International basketball activity in Yugoslavia started in the mid-1930s. At the end of spring in 1935 the first public basketball game took place before Zagreb audience with the competing teams of Sokolsko drustvo Zagreb II and Bulgarian students. The basketball team of YSC „Victoria“ from Sušak played two basketball matches hosting teams from Italy. On December 25, 1935, on Christmas Day, «Victoria» played against DA Fiume from Rijeka followed by the game versus «ROMSA» from Rijeka on February 12, 1939. Student national basketball selection of the Kingdom of Yugoslavia played its first international game against the B national team of Italy, which took place in Rome on March 20, 1938. In July of the same year, at Sokol competition in Prague, the Yugoslav national team played its first international game against Czechoslovakia. The initiative to admit Yugoslavia into the International Basketball Federation was made by the Sokol Association of the Kingdom of Yugoslavia. During 1936 FIBA received two requests to admit Yugoslavia into its membership. By the mid-December 1936, FIBA reported to the Sokol Association of the K.of Yugoslavia that it was to be regarded as a representative of Yugoslavia and the 31st member of FIBA.*

**Key words:** basketball, Sokol movement, the Kingdom of Yugoslavia, international games, FIBA

**Introduction**

A class of students at Springfield College made a request to their teachers to introduce some new and more interesting games within their regular physical education lessons, which were primarily based on gymnastics and some less-known sport games. Naismith, attending one seminar, showed off that he could make up a new game as to meet the demands of their students. Doctor Gulick, a teaching administrator, was willing to give Naismith this class in order to, among other things, encourage experimental work. Naismith had been working on this assignment for thirteen days by combining numerous variants of the existing sport games. On the fourteenth day he presented the world his new creation – basketball. This probably happened on December 21, 1891. As of the next year, 1892, this new game started spreading around the globe. Today, there is practically no country in which people do not play basketball. On December 1, 1939 Reverend Theodore Aszman of the First Presbyterian Church, in Lawrence, Kansas, giving service at James Naismith's funeral, said the following words: „It might be the sign of the God's providence to have the privilege and fortune of creating and leaving, as a heritage, to the next generation such thing as the basketball, a game of refined value and importance, which became a symbol of his life, resting upon a man of such virtue as James Naismith. (Colombo & Eleni, 1991, 7). France was the first European country to introduce the game of basketball. It was in 1893 following professor Rideout's arrival in Paris after his specialist's course for teachers of physical education at Springfield. Alongside with Emil Thies, a manager at YMCA in Paris, he started propagandizing for this new game.

Professor Rideout put the first basket construction in Europe at Young Men's Christian Association gymnasium in Rue de Trens in Paris on December 27, 1893. (Colbeck at all, 1972, 85-86). Basketball appeared early in the Czech Republic as well. As early as 1897, the school celebrations at grammar schools in Vysoké Myt, Bohemia, basketball was played on the initiative proposed by teacher Jaroslav Karasek. (Colbeck at all, 1972, 77). After a basketball presentation in Venice in 1907, at gymnastics competition organized by teacher Ida Nanni Pesciolini from Siena, this game was introduced in Italy. (Colbeck at all, 1972, 100). These two countries had a major influence on the development of basketball in former Yugoslavia. In this country basketball was first played by the students of Maribor Grammar School in the school year of 1905/06, as an initiative proposed by physical education and gymnastics professor Josip Jorga, PhD. As a substitution to football which was banned that year, the game of basketball was introduced. The first game was played between the teams of the Second Public Grammar School from Graz and the Royal Grammar School from Maribor. The game took place in Maribor on May 23, 1906. (1909 report, 52, according to Hočev, 24.02.1970, 1). William Wailland, a mission delegate of the Red Cross, came to Belgrade at the end of September 1923 in order to organize youth games and playgrounds. The course for elementary school teachers, gymnastics teachers, Sokol and scout leaders, took place on the playgrounds of Elementary School Savamali and the Cathedral from September 23 to October 18, 1923. Among other games, the course attendants were shown the basics of the game of basketball.

The citizens of Belgrade got acquainted with basketball in the first half of October 1923, and after the course it was played by the students of the Second Male Grammar School in Belgrade. After Belgrade, Wailland went to Sarajevo, Novi Sad, Bitolj, Skoplje, Niš, Zagreb, Split and Ljubljana, where he also demonstrated this new game. Soon after that, basketball was being played in almost every town in Yugoslavia. In Rijeka basketball was started playing in 1923, in Novi Sad in 1924, in Nis in 1925, in Mostar in 1926, in Tuzla in 1927, in Zadar in 1928 and in Zagreb in 1929. The aim of this paper is to highlight and bring out of oblivion the following aspects of basketball in this region: the first international team games, the first games of the national team of the Kingdom of Yugoslavia and the admission of the Association of Sokol of the K. of Yugoslavia to the International Basketball Federation. The historical method has been used in the process of writing of this work. We have researched and consulted libraries, archives and sport museum from former Yugoslavia. We hope to stir up sport historians and readers of all sorts to indulge themselves into further research of basketball development in the former Yugoslavia. We here wish to acknowledge the following professionals from the National Library in Belgrade (professors Dragan Barać and Slađana Milošević), Sports Museum in Novi Sad (Jovan Paunović) and Sports Museum in Zagreb (Zrinko Grgić) for their willingness to assist us while searching for specific and important historical sources.

### The first international team games

In the mid-1940s of the 20th century the first international team games were played as well as the first national team games of the Kingdom of Yugoslavia. Based on the up-to-date research it could be believed that basketball was played, first occasionally and without much organization, in Zagreb in spring of 1921, especially among school and Sokol youngsters. The first written information about basketball games dates from 1929. Basketball was started playing more intensively not just among pupils and Sokol members but also among university students. „We were lucky“, remembers Neferović, „to have many Bulgarian students at those days in Zagreb... they had also heard about basketball being played somewhere in Zagreb... at that time basketball was pretty much developed in Bulgaria... they would come to us... and then we would visit them to show us how to play basketball... we even had four Bulgarian national team members studying in Zagreb... so we had a chance to learn from them as well.“ (according to Paunić, 2007, 132). Soon the first practice sessions, promotional and public basketball matches took place. By the end of spring in 1935 the first public basketball game, before spectators in Zagreb, was played between Sokol Zagreb II team and Bulgarian students. A player from this match, Milan Kobali, said among other things: „By the end of spring in 1935, a presentation of Sokol Zagreb II took place, and as the last exercising exhibition was basketball.

Members of Sokol (Milan Kobali, Đan Tomić (Đan is a nickname for Jovan n.b.), Franjo Birtić, John Ames and Tomislav Vrkljan) played against Bulgarian students. Both teams wore white jerseys with Sokol members having red lining and blue belts whereas Bulgarian students had all-white jerseys and no belts. I do not remember who the first refereeing official was, probably Marijan Maržan. As it was just a presentation of basketball, the game duration was reduced to two halftimes of 5 minutes. Sokol won 12-2. The picture 1 shows many spectators around the entire playground (practice court) in the background. This was the first public and promoted game before audience in Zagreb – although it lasted shorter than a normal game. Spectators, mostly players' parents, relatives and Sokol members, saw basketball for the first time in their lives. I was not familiar with the impression the game had made on them – the only thing I know is that my mother liked it, and how couldn't she because I scored the first point“. (Kobali, 1986, 113). By the beginning of summer of the same year, Zagreb hosted one more basketball game. „The game was thought to be played again with the Bulgarian student, but due to the summer break most of them went homes.



Picture 1 – One basketball game in Zagreb in 1935. Back row from left to right: Neferović, a Bulgarian student, Maržan, Rokavec, a Bulgarian student. Front row: Ames, Birtić, Kobali, referee Zdenko Pavić, Stefanini, unknown.<sup>1</sup> Source: Owner of picture Z. Neferović, according to Paunić (1980, 602), according to Kobali (1986, 113).

<sup>1</sup> It can certainly be said that in both cases of public presentation of this photo, Paunić and Kobali had made mistakes in identifying the picture. Paunić put the following text below the picture: „Playground Zagreb 2, 1936 ... 'a presentational game'... at public practicing... numbers 1 and 5 (white) Bulgarians... the front row: Zagreb 2... referee: Pavić Zdenko... (in the front row with the ball)“. However, Kobali identifies the photo as we have done and additionally puts the following title „The players of a basketball game at a public practice in Zagreb in 1935“. It is obvious to conclude that this is the second game when, due to the summer break, there were not enough Bulgarian students so they had to make a combined team, which the photo shows. Kobali also said that all the players had white shirts whereas in this photo the two different teams can be easily identified. Furthermore, according to Kobali's memories, the referee at the first game was Marjan Maržan. Both authors undoubtedly claim that the game's referee was Zdenko Pavić, and Marjan Maržan was the player in this picture.

There were only two of them left so we had to fill in their line-up with our players. The referee was Zdenko Pavić". (Kobali, 1986, 113). Basketball at Sušak started during 1938 as a part of Yugoslav Sports Club „Victoria". Ljubo Prosen, who was actively involved in this process, said, among other things, the following: On the other side of the bridge, in occupied Rijeka, you could see young boys and girls throwing a ball, very much like the one you use in waterpolo, into a metal hoop with net, cheered by numerous spectators. People from Sušak were very sceptical about this game in the beginnings but soon they became interested on account of its liveliness. The name of the game was basketball or 'pallacanestro' as Italians called it... Not before 1938 was the basketball court built at Sušak stadium. I have vivid memories of a beautiful sunny morning in autumn when a group of swimmers and waterpolo players gathered at the Krimeja playground and patiently listened to the basketball teacher from Rijeka." (Prosen, 1951, 3). Following the initiative and great dedication of Justin Cuculović, the long-standing president of „Victoria", the basketball club was founded. The club, whose coach was Božo Grkinić, secretary Predrag Miculinić and administrator Nikola Grego, played many games and existed successfully until 1940, thus significantly contributing to the development of basketball at Sušak. Due to the vicinity of Rijeka, they had a possibility to visit this town often. These enthusiasts went to Rijeka almost every Sunday morning and played games with the basketball clubs from there. „We all liked that ", remembers Grego, „because it looked like an international game with all the rituals given from their side ". (according to Paunić, 2007, 139). Apart from Rijeka they also went often to Trieste to watch the championship games of Italian basketball clubs and took the opportunity to introduce themselves to this new game in that way too. The basketball rules of the game were translated from Italian by V. Pavešić and M. Pajalić. They practiced almost every day in order to have better results against the basketball players from Rijeka. This led to the first basketball game at Sušak, on Christmas Day, on December 25, 1938 with the team of DA Fiume from Rijeka. The team of YSC „Victoria" was represented by the following players: Josip Banić, Božo Grkinić, Vlado Polić, Ersilije Šikić, Nikola Grego, Mladen Bezjak and Dušan Zvonaš. According to the article „Is basketball going to reach us", published in a newspaper from Split called „Novo doba", dated December 28, 1938, the basketball players from YSC „Victoria" from Sušak were supposed to visit Zadar and play an international match against the team from that town. „On Christmas Day 'Victoria' played its first international game against Fiumana from Rijeka and was expected to be hosted by the team from Zadar". (according to Marović, 1982, 324). In the early 1939 on February 12, the game between 'Victoria' and ROMSA from Rijeka was played. The final score was 33-32 for the team from Rijeka. The 'Victoria' line-up was Ivica (or Ivan, n.b.) Šafar, Glavaš, Nikola Grego, Josip Banić, Mladen Bezjak, Božo Grkinić, Vlado Polić and Ersilije Šikić. (Pic. 2).



Picture 2 – Victoria from Sušak before the game against ROMSA (February 12, 1939) ending with the final result 33-32. Back row from left to right: Šafar, Glavaš, Grego, Banić, Bezjak, Grkinić; front row: Polić, Šikić. Source: Beganović et al. (2005, 155). During 1939 the basketball players of „Victoria" hosted one more international game against the team of DA Fiume from Rijeka. DA Fiume won 26-20. The following players played for „Victoria": Zdenko Tijanić, Božo Grkinić, Vladimir Polić, Josip Banić, Ersilije Šikić, Mladen Bezjak, Nikola Grego and Ljubo Prosen.

Besides the photo of „Victoria" published in the monograph titled „Victoria – Primorje 1908-1998", other details about the game could not be. The games between the teams from one country were often referred by international referees. Following this rule the game between YSC „Victoria" from and Sokol Zagreb II, played at the Sušak town stadium on June 8, 1939, was referred to by an Italian, Mr. Artelli from Rijeka.



Picture 3 – Basketball players of Victoria from left to right: Zdenko Tijanić, Mladen Bezjak, Božo Grkinić, Vladimir Polić, Josip Banić, Nikola Grego, Ersilije Šikić and Ljubo Prosen, after the game against D.A. Fiume (20-26) at Sušak in 1939 Source: A photo from „Primoje" sport club archives, Cucilić (1998, 66).

The first games were played with such a zeal and excitement, like the waterpolo games, and the first scores and point were cheered and supported as described in the following text: „There was much enthusiasm and will... all of us were like that... not just me ", remembers Božo Grkinić, „we breathed like one soul... or better to say we had a strong will... the games against Italians were in fact international as we lived in two different countries... but the quality of the performance was not that much international... at least from our side... We used to play waterpolo before that... which gave us certain technique..."

"...There was a shot in waterpolo called 'parabola'... which is similar to every attempt made on basket... we simply took that and applied it to this ground sport of basketball... this was a novelty for Italians, who already had some experience on the ground... their journalists noticed that we have something specific... and this was something we took from waterpolo in which we were better than Italians even then... the war ended every activity at Sušak, but Italians continued playing basketball even so." (according to Paunić, 2007, 140). Those „first matches with the teams from Rijeka were of course 'bitter' " says Prosen, „however, the sport talent and consistency of some individuals soon came to be noticed. Božo Grkinić, a well-known swimmer and a member of national waterpolo team, set his playing performance onto the level of the best players from Rijeka. Other players, who were standing out besides him were Bezjak brothers, Grego, Tijanić, Vlado Polić and others. They gave the team the necessary quality to match their rivals from Rijeka." (Prosen, 1951, 3)

### **The first international games of the national team of the Kingdom of Yugoslavia**

Following the abovementioned club games at the international level, the national team of the Kingdom of Yugoslavia played its first international match in the first half of 1938. Students' national team of Yugoslavia, composed of the players from Sokol Zagreb II played the first international game against the national team B of Italy in Rome on March 20, 1938. Italians won 59-17. The Yugoslavs played so badly in the first half that they did not score a single point. The halftime result was 33-0 for Italians. The players for Yugoslavia were: Milan Kobali, Jovan Tomić, Zvonimir Neferović, Zdenko Tončić, Senio Sinobad, Tonković and Tomislav Vrkljan. Kobali, an active participant and the player in that game, said, among other things, the following about that game: „There were only seven of us who went to play that game (Kobali, Neferović, Sinobad, Tomić, Tončić, Tonković, Vrkljan) under the name of students' national team of Yugoslavia, and we played the first game outside our country in Rome on March 20, 1938. The first halftime was a complete disaster. Italian students took the lead of 33-0. In the halftime break, besides wiping the sweat off, we quickly analyzed Italian game on both offense and defense and agreed to copy their game. And that brought us some success as the second halftime resulted in 26-17 for Italians. So the two halftimes taken combined, the final result was 59-17 for Italians. We consoled ourselves that it had been a valuable experience for us so we were not that much depressed". (Kobali, 1986, 117) (Picture 4). Jovan Tomić, a member of the national team recalls: „We travelled to Rome by train and stayed there for seven days. There were eight of us players and five officials. The preliminary game on a small open stadium was played between Italy and Hungary. There were many spectators, and the Italian players amazed us by how skilfully they played and how dominantly they won the game. We came

there with only white shirts and no numbers, so we were given green jerseys with numbers. After the game a reception was held where we were given medallions." (according to Švegar, 1987, 134). Jovan Tomić confirms in his memories that there were eight players. However, Božidar Mačević says the following: „In 1938 I played for the national basketball selection of Yugoslavia against Czechoslovakia in Prague. I didn't play against Italy B in Rome although Milan Kobali mentioned my name in book 'Košarka', Zagreb, 1957." (according to Švegar, 1987, 134)<sup>2</sup>.



Picture 4 – Student basketball team of Yugoslavia at its first international competition in Rome in 1938 Source: Beganović at all (2005, 48).

This first international game of students' national team of Yugoslavia had a multiple influence on the development of basketball in Yugoslavia. It also largely influenced the future successful development of basketball in Zagreb, i.e. Sokol Zagreb II. Kobali says that 1938 was a very important year in the development of basketball in Zagreb. „We had two encounters with the European basketball and we noticed that their quality was better than ours. We were actually autodidacts, without a proper coach, with no knowledge about the possibilities in basketball techniques and tactics. That's why the game against Italy II together with watching the game between Italy I and Hungary had been a valuable experience. We took this opportunity to obtain some basketball literature. The book's title was Pallacanestro and it was in Italian." (Kobali, 1986, 117). At 10th Sokol competition in Prague in 1938, among other competitions in different sports, there was also basketball. The national team of the Kingdom of Yugoslavia played at this competition its first international game versus Czechoslovakia on July 5, 1938. The Czechoslovaks won 76-28. The Yugoslav national team was represented by the following players: Johan Ames, Milan Kobali, Josip Kozjak, Božidar Mačević, Božidar Stefanini, Jovan Tomić, Zdenko Tončić and Anđelko Volzajn.

<sup>2</sup> An interview given to Švegar on October 13, 1985 in Zagreb. In the book „Košarka“ from 1957 quoted by the author there are only the names of the national team members playing in Prague while the players from Rome are not listed (Kobali, 1957, 8)

The Yugoslav team leader was Zvonimir Neferović and Zdenko Tončić was the team captain. The participant of this event and the player on the team Milan Kobali says: „An opportunity to learn more about basketball was given to us the same year again. During the 10th Sokol competition in Prague on July 5, 1938<sup>3</sup> we played against Czechoslovakia as the national team of Yugoslavia. Of course, we lost the game. The result was 76-28.

The Czechoslovaks scored more points than Italians but then again we scored 11 points more than at our first game against Italians. We were still lagging back in our defense but our experience from Rome was used to our advantage. The Czechoslovaks were then rather sound and respectable basketball team “. (Kobali, 1986, 117) (Pictures 5 and 6).



Picture 5 – Prague, July 5, 1938, Sokol national team of the Kingdom of Yugoslavia at international Sokol competition, from left to right: Tončić, Ames, Stefanini, Volzajn, Neferović (team leader), Kozjak, Tomić, Mačević and Kobali. Source: Photo documentation of Serbian Basketball Federation, according to Čobović, Raičević & Bogdanović (2005, 10).



Picture 6 – Before the game in Prague on July 5, 1938. Nine Czechoslovakian and eight Yugoslav players (in the same shirts). Back row from left to right: 4. Tončić, 7. Kozjak, 5. Volzajn, 9. Tomić. Front row: 3. Kobali, 8. Stefanini, 10. Ames, 6. Mačević. Source: Kobali (1986, 114).

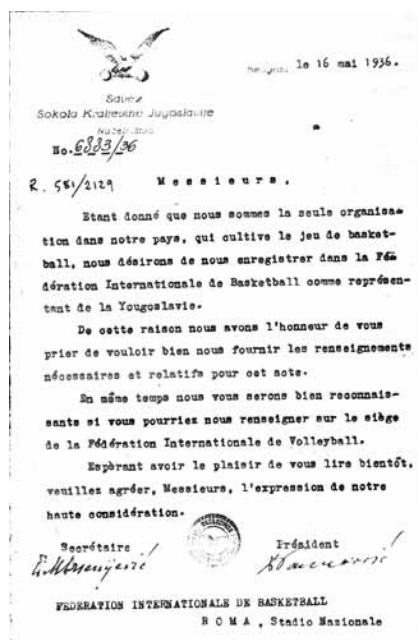
Sokol from Split were there at the competition, and they watched the basketball games together with other sports. Among them was a youngster named Uroš Tominić. He watched basketball games and he liked the game very much so „he bought a basketball in Prague wishing to have this dynamic and beautiful game played in Split “(Marović, 1982, 325).

### **The admission of the Yugoslav sokol association into the international basketball federation**

Following the request submitted by the basketball federations of Czechoslovakia, Switzerland and Italy, doctor Elmer Berry, director of YMCA School of Physical Education, sent an invitation letter to the members of International Amateur Handball Federation (IAHF) for a meeting in Geneva to discuss the current basketball issues. The first International Basketball Conference was held on June 18, 1932. The following people attended the meeting: Attilio Ponisio (Argentina), Simeon Mavroskufis and John Anadjoslou (Greece), Count Giorgio Asinari di San Marzano (Italy), Joseph Shadeiko (Lithuania), Henry Brandt (Portugal), D. D. Teica (Romania), Leon Bouffard, Maurice Abramowicz, Emile Huguenin, Henry Luciri (Switzerland) and Ladislav Kapucian (Czechoslovakia). This meeting was the origin of International Basketball Federation (Fédération Internationale de Basket-Ball FIBB). Leon Bouffard (Geneva, Switzerland) was elected for the first president, and William Jones for secretary-general.

Taking into the consideration that basketball was started playing first among the Sokol youth and in their clubs and the Sokol members were the initiators of the basketball games, it seemed rather logical to have the Sokol Association of the Kingdom of Yugoslavia (SAKY) admitted into the International Basketball Federation (FIBA). SAKY sent a letter (No. 6883/36) dated May 16, 1936 and addressed to „Federation Internationale de Basketball, Roma, Stadion Nazionale“. In that letter, the International Basketball Federation was informed that SAKY is the only association in Yugoslavia with basketball playing activity, and expressed a desire to be admitted into the Federation as a representative of Yugoslavia. Moreover, the Federation was kindly asked to forward all the necessary information and documents regarding the admission process. Here is the entire letter: „Messieurs, Etant donné que nous sommes la seule organisation dans notre pays, qui cultive le jeu de basketball, nous désirons de nous enregistrer dans la Fédération Internationale de Basketball comme représentat de la sentat de la Yougoslavie. De cette raison nous avons l'honneur de vous prier de vouloir bien nous fournir les renseignements nécessaires et relatifs pour cet acte. En même temps nous vous serons bien reconnais sants si vous pourriez nous renseigner sur le siège de la Fédération Internationale de Volleyball.

<sup>3</sup> In his two earlier books, *Košarka* (1957, 8) and *ABC košarke* (1971, 10) Kobali does not state the date of the game in Prague while Bojanić states the date of the game as July of 1938 (1997, 12).



Picture 7 – The letter of SAKY to FIBA dated May 16, 1936. Godine. Source: FIBA archives, according to Paunić (1980, 597).

Espérant avoir le plaisir de vous lire bientôt, veuillez agréer. Messieurs, l'expression de notre haute considération".<sup>4</sup> (Picture 7). The International Basketball Federation, upon the receipt of the letter, four days later on May 20, 1936, sent a reply (No.S.581/2031) to the president of the Sokol Association of the Kingdom of Yugoslavia at its headquarters in Belgrade, 34 Prestolonaslednikov Trg, Yugoslavia. The reply expressed the pleasure of SAKY having an interest to join F.I.B.A. and sent further instructions for the admission. We have considered it necessary to have the entire letter presented in this paper: „Cher Monsieur, Je vous remercie pour votre lettre du 16 courant. J'ai pris note, avec le plus vif plaisir, de votre désir de devenir membre de la F.I.B.A. Sous plis séparé je vous envoie par ce même courrier une copie du règlement de jeu en Français et en Anglais, ainsi qu'une copie des Centraux et des règlements internes publiés à ce jour. Comme vous verrez, l'article 5 des Statute donne la définition de la qualité de membre de la F.I.B.A. il est notamment nécessaire d'être une organisation d'envergure nationale. Je suppose que tel est le cas avec votre Fédération. La taxe annuelle d'affiliation est de 50.00 francs or (francs suisses). Même si vous n'envoyez pas de prendre part aux prochaines Olympiades de Berlin, je vous conseille de vous affilier immédiatement qui nous parviendrait après le prochain Congrès de la Fédération sera majorée d'une taxe d'admission de 100.00 francs or.

<sup>4</sup> Gentlemen, being the only organization in our country in which basketball are played, we wish to be accepted by the International Basketball Federation as a representative of Yugoslavia. Therefore, we would be honored to have all the necessary information sent by you. At the same time, we would also be grateful to be informed about the headquarters of the International Volleyball Federation.

La demande d'affiliation doit être faite per une lettre signée du Président et du Secrétaire demandant l'affiliation et être accompagnée per le chèque relatif, deux copies des statuts et des règles du jeu en force dans votre Pays, ainsi qu'un court rapport statistique sur l'activité du Basketball en Jugoslavie. Le Volleyball est contrôlé par la International Amateur Haddball Federation, 9, Hardenbergstrasse, Berlin. Veuillez agréer, cher Monsieur, mes meilleures salutation sportives."<sup>5</sup>.

Enclosed were the Rules of the game of basketball, in both English and French, and a copy of statute and regulations. After they had collected the necessary documents, SAKY sent an admission request to the International Basketball Federation. The original letter could not be obtained even after a thorough review of the related documentation, which left us unfamiliar with the content and the date of the mentioned letter. The letter of the International basketball Federation (No.S.581/2502) dated December 12, 1936 and sent to the president of SAKY, informed them of being acquainted with their request and being welcome to join FIBA. Cher Monsieur, C'est avec grand plaisir que j'ai reçu votre demande d'affiliation à la F.I.B.A. et que, au nom du Bureau Central, at des 30 Pays members, je done e la bienvenue parmi nous à votre Fédération. J'espère que, à l'avenir, nos relations semont frequentes et pleines de bons resultats pour le Basketball de votre Pays et du monde entier. Veuillez agréer, cher Monsieur, mes meilleures salutation sportives."<sup>6</sup>.

<sup>5</sup> Dear Sir, we thank you for your letter dated December 16. We are very much pleased with your request to become members of F.I.B.A. We also send you the Rules of the game of basketball, in both English and French, and a copy of statute and regulations. As you may see, the Article 5 of the statute defines the membership to F.I.B.A. In order to become members of F.I.B.A. you should be an organization at national level. We assume such is the case with your Federation. The annual membership fee is 50 golden francs (or Swiss francs). Even if you do not plan to compete at the forthcoming Olympic Games in Berlin, we kindly advise you to submit your documentation and pay the fee for the year of 1936, as the membership fee will increase up to 100 golden francs (or Swiss francs) after the Congress of Federation. Your request should be submitted alongside with the letter signed by the president and secretary-general and an enclosed cheque and two copies of the Statute and the Rules of the game in Yugoslavia. Volleyball is under the jurisdiction of International Amateur Handball Federation, 9, Hardenbergstrasse, Berlin.

<sup>6</sup> Dear Sir, it is our pleasure to inform you that we have received your request to be accepted as members of F.I.B.A. and, on the behalf of the Central Bureau of 30 member states, we wish to express our welcome to your Federation. We truly hope to stay in touch with you in the future as to achieve good basketball results in your country and the wider world.

Based on the content of the letter and the following words in it, „and, on the behalf of the Central Bureau of 30 member states, we wish to express our welcome to your Federation“, it can be concluded that by the mid-December of 1936 the SAKY was admitted into the International Basketball Federation as the representative of Yugoslavia. Following the intentions from the letter, „we truly hope to stay in touch with you in the future as to achieve good basketball results in your country and the wider world“, the further contacts were cherished regarding all the important issues on the basketball development. The International Basketball Federation sent a letter to SAKY on February 16, 1940 to inform them about the international exam for referees in order to send the names of the two candidates (referees), who had some previous knowledge to be eligible for the refereeing exam. SAKY replied on March 13, 1940 (No.2111/40) to the International Basketball Federation saying the following: “Nous référant a votre lettre du 15 fevrier, nous avons l'honneur de vous fair connaitre les noms de deux nos juges, qui sont capables de condair les rencontriées intenationales. A savoir; Messieurs, Radovanović Salimir et Kobali Milan.”<sup>7</sup> (Pic. 8).

In the end, we consider it necessary to quote one note which appeared in Pavić's rules of the game from 1939 saying that: „In the XII Olympic Games in 1940 our Federation will be represented by one team playing for Yugoslavia“. Paunić also says that the note should be trusted because it comes from a „trustworthy“ person.<sup>8</sup> (Paunić, 1980, 257).



Picture 8 – The letter of SAKY to FIBA dated May 16, 1936  
Source: FIBA archives, according to Paunić (1980, 597).

<sup>7</sup> Replying to your letter dated February 16th, we have the honour to inform you about the names of two referees, who have the necessary knowledge to be eligible to pass the exams for international referees. We suggest Selimir Radovanović and Milan Kobali.

<sup>8</sup> Vera and Zdenko Pavić, the parents of Marko Pavić, the author, became the members of technical committee of SAKY for the games in 1935.

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## MEĐUNARODNA KOŠARKAŠKA AKTIVNOST U KRALJEVINI JUGOSLAVIJI

### Sažetak

Međunarodna košarkaška aktivnost u Jugoslaviji započela je u srednjim 30-im godinama 20. stoljeća. Pri kraju proljeća 1935, prva javna košarkaška utakmica odigrana je pred Zagrebačkim auditorijem s protivnicima 'Sokolsko društvo Zagreb II' i Bugarski studenti. Košarkaška momčad YSC „Victoria“ iz Suša odigrala je dvije košarkaške utakmice protiv gostiju iz Italije. Dana 25 prosinca 1935, na Božić „Victoria“ je igrala protiv „DA Fiume“ iz Rijeke a poslije i utakmicu protiv „ROMSA“ iz Rijeke dana 12. veljače 1939. Studentska državna košarkaška selekcija Kraljevine Jugoslavije igrala je prvu međunarodnu utakmicu protiv B državne momčadi Italije, što se odigralo u Rimu 20. ožujka 1938. U srpnju iste godine, na Sokolskom natjecanju u Pragu, Jugoslavenski državni tim igrao je svoju prvu međunarodnu utakmicu protiv Čehoslovačke. Inicijativa da se Jugoslavija primi u Međunarodnu košarkašku federaciju izvršena je od strane Sokolskog udruženja Kraljevine Jugoslavije. Kroz 1936 FIBA je primila dva zahtjeva za primanje Jugoslavije u svoje članstvo. Sredinom prosinca 1936, FIBA je izvijestila Sokolsko udruženje Kraljevine Jugoslavije da ga pozdravlja kao predstavnika Jugoslavije kao 31. člana FIBA.

**Ključne riječi:** košarka, Sokolski pokret, Kraljevina Jugoslavija, međunarodne utakmice, FIBA

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## DIFFERENCES IN FOOTBALL PLAYERS' OF VARIED LEVELS OF COMPETITION IN DIFFERENT BALANCE CAPABILITIES

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*Original scientific paper*

### Abstract

*Ability of balance, balance football players, are very important in maintaining proper function of body position at shooting, duel, drop especially in the prevention of injuries. The aim was to determine differences in the ability of balance, football players of different levels of competition in Bosnia and Herzegovina. The survey was conducted in the 2007/2008 season, included 129 football players, seniors, different levels of competition (5 levels): I-level (National Team), II-level (Premier League), III-level (First League), IV-level (Second League) V-level (Cantonal League). To test the ability of the balance was used Biodex Stability System (Level 4 of the complexity of the test, stability level 4 in the duration of 20 seconds) index of stability. Determining the difference between levels was done T-test for independent samples. The results showed statistically significant differences between the third and fourth level III-level (First League) and level IV (Second League),  $p < .05$  in favour of the fourth level, and between other levels there is no statistically significant difference. The survey did not show the expected difference between the levels of competition. It was expected that the differences between levels are in favour of quality competition, which has not happened.*

**Key words:** *difference, balance, football, levels of competition*

### Introduction

From the perspective of structural analysis (Mikić, Talović & Rađo, 2003) state that football is one of the semistructural sports activities in which they were equally represented moving acyclic and cyclic structures. Football contains all forms of natural movements like running, stops, turns, jumps, falls, throws, pushing, taking place at a different intensity, pace and duration, for the purpose of defense and strike action. The number of games that players play in a continually growing season, the number of training sessions a week has increased, and recovery time between training and shorten the game, and all these increase the risk of injury (Marković & Bradić, 2008). Reading "the situation demands of football players and the timely and appropriate responses to them, with movement in space and time, the performance of certain movements and taking a proper position.

Shooting, duel, land, receptions ball dribbling, are just some of the football action which should be the conscious or subconscious level, maintain the equilibrium position, perform the task and avoid injury. This leads to the conclusion of the great importance of the ability of balance or balance in soccer. Balance is the ability to keep the body in the equilibrium position and that the correct movements, against the action of gravity to gravity, which makes it difficult to maintain the equilibrium position of the activities of external stimulus (Malacko & Rađo, 2004). To assume that the equilibrium level of ability in all football players is not the same, which causes the level, quality and requirements of the competition.

This paper attempted to determine ability of balance or equilibrium level football players in the competition, and gain insight into the differences.

### Problem and the aim

The quality of football games determined the level of competition or the league, ranking in the competition is taking place, and goals that are set before the football players. To meet the demands of the game of the competition level and goals, the entire football players should reach the status of anthropological model associations requests league level. It is necessary to adapt to, transformed to fit the requirements of the game. The level of quality, tempo and intensity football game depends on the quality and preparedness of the players which is again different and depending on the level of competition. The problem of determining the difference in the ability of balance football players of different levels of competition. Aim of the research is to gain insight into the differences in the abilities of balance football players of different levels of competition and to make the degree of gradation levels of income.

### Methods

#### *Sample of examinees and of variables*

The study sample of respondents representing 129 football players, senior club and representative level of competition in B&H, which are registered in FA B&H.

The survey was conducted during the season 2007/2008. Research are represented by all levels of competition, five (5) levels: I-level (the National Team U-21), II-level (Premier League), III-level (First League) IV-level (Second League) V-level (Cantonal League). To assess the balance, the balance was used variable MBYS - index of stability. To test the ability of the balance was used Biodex Stability System complexity level 4 test, the stability level 4 in the duration of 20 seconds. Numbered index of stability, lower value is better.

#### *The method of data processing*

For the analysis of differences between all groups, representatives from all levels of competition, used a T-test for independent samples. T-test to determine statistical significance of differences arithmetic mean of two samples (Dizdar, 2006). In this paper the T-test used to determine the differences between the five levels of competition.

### **Results and discussion**

During the football action some muscles are responsible for carrying out the movement and the other to maintain balance during the execution of these movements. The ability of balance is important in football, the function of the execution of movement and prevent injuries. Therefore it is important to us football players know the situation when it comes to equilibrium (Sherry, 2002). Table 1 shows the results of T-test, where they compared mean values of I-level competition with the other grade levels. The results show that there was no statistically significant difference between the I - level of competition and other levels.

Table 2 shows the results of T-Test II-level in relation to the III, IV and V-level competition, where again no difference in the ability of balance. Table 3 puts in relation with the level III-IV and V-level competition. Statistically significant difference is seen only between III and IV level in favour IV. Table 4 shows the difference between IV and V levels of competition, where again there is no statistically significant difference. Results T-test for independent samples showed that we generally no statistically significant differences in the ability of balance football players at different levels of competition, except the difference between the third and fourth levels to the benefit of the fourth. The question arises why we have differences and why the differences are not accompanied by the level and quality of the competition. Would be logical that I-level for its quality, the demands of competition, selection and training technology shows the best results and the other levels are sorted by grade behind him. Stimulate systematic proprioception balance training. Proprioception is the ability of the body to convey a sense of joint position, interpreting the information got in the CNS and conscious or subconscious responses to stimulus, to allow proper execution of the movement and maintenance of the body paragraph (Dervišević, 2006). Aware of the movement initiated in the cortex are too slow to prevent injuries in emergency situations, and are supposed to through spinal reflexes may occur more quickly and timely activation of the stabilizer muscles (Ergen, 2007). To assume that the non-systematic selection and inadequate and insufficient application of modern simulation technology proprioceptive training is conditional on all the tested levels of competition, not the existence of differences between levels.

Table 1 - Results of T-test between levels of competition

#### Results of T-test 1st and 2nd levels of competition

|      | Mean  | Mean  |         |    |      |
|------|-------|-------|---------|----|------|
|      | G_1:1 | G_2:2 | t-value | df | p    |
| MBYS | 6,117 | 6,750 | -,73158 | 56 | ,467 |

#### Results of T-test 1st and 3rd levels of competition

|      | Mean  | Mean  |          |    |      |
|------|-------|-------|----------|----|------|
|      | G_1:1 | G_2:3 | t-value  | df | p    |
| MBYS | 6,117 | 7,271 | -1,24706 | 56 | ,218 |

#### Results of T-test 1st and 4th levels of competition

|      | Mean  | Mean  |         |    |      |
|------|-------|-------|---------|----|------|
|      | G_1:1 | G_2:4 | t-value | df | p    |
| MBYS | 6,117 | 5,419 | ,75681  | 49 | ,453 |

## Results of T-test 1st and 5th levels of competition

|      | Mean  | Mean   |         |    |      |
|------|-------|--------|---------|----|------|
|      | G_1:1 | G_2:5  | t-value | df | p    |
| MBYS | 6,117 | 6,7095 | -,60251 | 50 | ,550 |

## Results of T-test 2nd and 3rd levels of competition

|      | Mean  | Mean  |         |    |      |
|------|-------|-------|---------|----|------|
|      | G_1:2 | G_2:3 | t-value | df | p    |
| MBYS | 6,750 | 7,271 | -,60852 | 54 | ,545 |

## Results of T-test 2nd and 4th levels of competition

|      | Mean  | Mean  |         |    |      |
|------|-------|-------|---------|----|------|
|      | G_1:2 | G_2:4 | t-value | df | p    |
| MBYS | 6,750 | 5,419 | 1,63561 | 47 | ,109 |

## Results of T-test 2nd and 5th levels of competition

|      | Mean  | Mean   |         |    |      |
|------|-------|--------|---------|----|------|
|      | G_1:2 | G_2:5  | t-value | df | p    |
| MBYS | 6,750 | 6,7095 | ,04523  | 48 | ,964 |

## Results of T-test 3rd and 4th levels of competition

|      | Mean  | Mean  |          |    |      |
|------|-------|-------|----------|----|------|
|      | G_1:3 | G_2:4 | t-value  | df | p    |
| MBYS | 7,271 | 5,419 | 2,049680 | 47 | ,046 |

## Results of T-test 3rd and 5th levels of competition

|      | Mean  | Mean   |         |    |      |
|------|-------|--------|---------|----|------|
|      | G_1:3 | G_2:5  | t-value | df | p    |
| MBYS | 7,271 | 6,7095 | ,57659  | 48 | ,567 |

## Results of T-test 4th and 5th levels of competition

|      | Mean  | Mean   |          |    |      |
|------|-------|--------|----------|----|------|
|      | G_1:4 | G_2:5  | t-value  | df | p    |
| MBYS | 5,419 | 6,7095 | -1,38930 | 41 | ,172 |

## Conclusion

During the game musician to perform various forms of football acyclic movement. Given the diversity and richness of movement in whole, football is one of the most complex sports games. Football movement require a significant level of capacity balance, proprioceptive quality football action in the function (Schmid, 2002). The results of this study showed that differences capacity balance football players at different levels of competition in B&H, generally not exist. The reasons lie in the selection and training technology is being applied. It is obvious that balance training is targeted at soccer practice represented in the treated sample. Guided by the results of this work, a systematic approach is necessary to balance technology training,

balance and stimulate the quality of the training process of which have multiple effects, which include the prevention of injuries. Proprioception training football players put in balance the unstable situation, which causes receptor activation. Thus, that creates a presumption that the actress when found in an unfavourable position for your wrist, to respond to the function to avoid injury or even execution of movement and settlement football task (Reilly, 2000). Prepare for the demands of football and positions body movement, prevention of injuries, improve football performance and result in the end, the goals that we can make use of technology, training of balance.

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## RAZLIKE KOD NOGOMETAŠA VIŠE RAZINA NATJECANJA U RAZLIČITIM SPOSOBNOSTIMA RAVNOTEŽE

### Sažetak

Sposobnost ravnoteže, ravnoteže nogometaša je iznimno važna u očuvanju odgovarajućih funkcija pozicije tijela kod šutiranja, igre u duelima, bacanjima, i to posebno kod prevencije povreda. Cilj je bio utvrđivanje razlika u sposobnosti ravnoteže nogometaša različite razine natjecanja u Bosni i Hercegovini. Istraživanje je provedeno u sezoni 2007/2008 i uključilo je 129 nogometaša seniora različitih (5 razina) razina natjecanja: I-razina (Nacionalni tim), II-razina (Premier liga), III-razina (Prva liga), IV-razina (Druga liga) i V-razina (Kantonalna liga). Za testiranje ravnoteže korišten je Biodex Stability System (četvrte razine kompleksnosti testa, u trajanju od 20 sekundi) indeks stabilnosti. Razlikovanje grupa izvršeno je T-testom za neovisne uzorke. Rezultati su pokazali statistički značajne razlike u ravnoteži između nogometaša Prve lige i nogometaša Druge lige, uz  $p < .05$  u korist drugoligaških igrača, dok u ostalim slučajevima nije bilo značajnih razlika. Istraživanje nije donijelo očekivane rezultate u odnosu na razine natjecanja. Očekivano je da će se iskazati razlike u korist natjecatelja kvalitetnijih (viših) razina, što se nije desilo.

**Ključne riječi:** razlike, ravnoteža, nogomet, razine natjecanja

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