

# SPORT SCIENCE

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*Dear reader,*

*In front of you there is a second issue of journal that continues with quality professional and scientific articles publishing. In that manner we successfully finalized year 2008, a year in which journal publisher – Faculty of Kinesiology (University of Travnik) performed two more substantial steps toward high quality reaching. Namely, faculty relocates into new private, extremely nicely arranged environment and ensured long term solution for performing education and scientific processes on high quality level. Moreover, with appropriate amenable authorization, faculty activates postgraduate master studies according to Bologna models 4+1 and 3+2, so it is included among credible educational institutions. All of that important doings include several cooperatives and among them especially Faculty founder Nihad dr Selimović. Owing to its wideness, Sport Science journal become interesting for many authors and is not surprising a number of articles that arrived. From those articles, in this issue we include some that relate sport games: basketball, handball and football. In addition, few articles relate structural changes or morphological-motor dimensions in education. Furthermore, we include articles from management (sport manifestation analysis and project managers position), as well as from philosophy (pneumrhythmy), history (water-polo rules), kinesitherapy (foot arch in kids), didactical principles in sport, promotion of Hapkido martial art and effects of fitness program with students. Finally, two articles concern sports that are usually less represented in such journals – race walking and free climbing. We hope that journal will hereafter ensure equally interesting articles, and we invite you to send us your papers from all kinesiological areas or disciplines that touch kinesiology.*

*Editor-in-Chief*

*Assist.Prof. Dobromir Bonacin, PhD*

*Dragi čitatelju,*

*Pred tobom je drugi broj časopisa koji nastavlja s objavljivanjem kvalitetnih stručnih i znanstvenih priloga. Tako je uspješno završena 2008. godina u kojoj je Izdavač časopisa – Kineziološki fakultet Univerziteta u Travniku, učinio još dva bitna koraka u pravcu dostizanja pristojne razine kvalitete. Naime, fakultet je preselio u nove vlastite iznimno lijepo uređene i opremljene prostorije te tako osigurao dugoročno rješenje za kvalitetno odvijanje nastavnih i znanstvenih procesa. Također, uz dozvolu nadležnih tijela, fakultet je pokrenuo poslijediplomski magistarski studij po bolonjskom modelu 4+1 i 3+2, čime se uvrstio među vjerodostojne edukacijske institucije. U svemu tome sudjelovalo je više suradnika a među njima posebno osnivač Kineziološkog fakulteta Nihad dr Selimović.*

*Zbog svoje širine časopis Sport Science postao je zanimljiv mnogim autorima pa ne iznenađuje veliki broj pristiglih priloga. Od prispjelih priloga u ovaj su broj uvršteni oni koji se odnose na sport: košarku, rukomet i nogomet. Zatim na strukturalne promjene i morfološko-motoričke dimenzije u edukaciji. Nadalje, na menadžment (analiza održanih sportskih manifestacija, te poziciju projektnih menadžera). Također su tu i članci iz filozofije sporta (pneumritmija), povijesti (pravila vaterpola), metodologije (taksonomske procedure), kineziterapije (svod stopala kod djece), didaktički principi u sportu, te prikaz Hapkido borilačke vještine i efekata fitness programa. Konačno dva priloga se odnose na sportove koji su obično manje zastupljeni u časopisima, tj. na brzo hodanje i slobodno penjanje. Nadamo se da ćemo vam i ubuduće osigurati jednako zanimljive članke. Ovim putem vas pozivamo da nam pošaljete svoje članke iz svih područja koje kineziologija ispunjava i dodiruje.*

*Glavni urednik*

*doc.dr Dobromir Bonacin*

## NONSTANDARD INDICATORS OF THE OFFENSIVE EFFECTIVENESS IN BASKETBALL AND SUCCESSFULNESS OF BASKETBALL TEAMS

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*Original scientific paper*

### Abstract

*Analysis of new nonstandard indicators of the offensive effectiveness has been done in research project comprising 50 basketball games in "Bosnian League 6" and Regional "Goodyear Basketball League" (now known as NLB League). This scientific paper, with the help of Discriminative Analysis on new nonstandard indicators, showed which variables separate winning teams from losing teams in Bosnian League 6 and regional league, as well as which variables separate winning teams in two different quality ranks of competition.*

**Key words:** *successfulness, basketball, win, situational indicators, discriminative analysis, Bosnian League 6, regional basketball league, transition offense and set offense*

### Introduction

One fact that motivated our research of the game of basketball was the fact that modern basketball is totally devoted to requests of basketball fans who by attending games want to enjoy in its dynamics and attractive plays. Our wish is to give you a closer look in professional and scientific conception of basketball. Having in mind obvious difference in quality between Bosnian League 6 and regional basketball league, we used this research as an attempt to define which nonstandard indicators of offensive effectiveness determine successfulness (to win or to lose a game) in Bosnian League 6 and regional basketball league. Offensive and defensive effectiveness in most cases depend on the ability of all players to transform at the same time as fast as possible from one to the other activity (Trninić, 1995). In terms of offense this means to come by opportunity to execute a fast break as the most effective way of offense, and then execute a set play.

### Aim of the research

Aim of this research is to determine if 6 new nonstandard indicators of offensive situational effectiveness in the game of basketball distinguish winning from losing teams in Bosnian League 6 and regional league. Through explaining results that determine which variables mostly distinguish winning from losing teams in Bosnian League 6 and regional basketball league, conclusions have

been presented with regard to qualitative difference in these two ranks of competition.

### Methods

#### *Entity sample*

Entity sample comprises all played games, 30 games of basketball teams in Bosnian League 6 for the champion of Bosnia and Herzegovina and 20 games in regional Good Year League (now known as NLB). Base for data processing therefore comprises 50 games or total number of 100 nonstandard statistical patterns. Data is collected by official statisticians as they go through game video tapes.

#### *Variables sample*

Situational effectiveness therefore presents just a part of total successfulness that can be measured by game stat notes. Standard pattern of situational effectiveness doesn't give enough information to have more accurate estimate about the structure of successfulness of a basketball team (Dežman, 2002). We chose to perform more detail analysis with the help of newly created pattern for following offensive effectiveness in order to get more information for analyzing successfulness in basketball. By increasing number of game information we can also increase prognostic quality of analysis of the outcome of basketball games (Hajnal, 2002). Starting from the remark that balance, relationship between the number of transition

and set plays, is the most important in collective approach to offense. (Šeparović, 2007), we have determined that successfulness of performing transition and set offense influences final outcome of the game in Bosnian League 6 and regional basketball league (NLB).

#### *Variables*

Selective variables:

1. league: regional – Goodyear (now NLB) – Premier League (G-B)
  2. game outcome: win – loss (1-0)
- Variables on the type of offense:
1. transition offense – successful (TU),
  2. transition offense – unsuccessful (TB),
  3. transition offense – neutral (TN),
  4. set offense – successful (PU),
  5. set offense – unsuccessful (PB),
  6. set offense – neutral (PN).

We recognized successful offensive play, either transition play or set play, as a made shot from 3 point range, made shot from 2 point range, and forced personal foul followed with 2 free throws. Unsuccessful offensive play, transition or set play is recognized as missed shot from 3 point range, missed shot from 2 point range and turnover (lost possession of a ball). In both set and transition play, we also recognized situation when the offense was neither successful nor unsuccessful by our standards, therefore leaving it to be considered as neutral. Neutral outcome of transition offensive play or set offensive play relates to forced personal foul, inbound play and offensive rebound.

#### *Data processing methods*

For analyzing of groups, data processing was done in the following way: descriptive statistical parameters were calculated, by applying canonical discriminative analysis testing of important features of discriminative function by Burtlett  $\chi^2$  test it has been determined if there is a statistically important difference between winning and losing teams in Bosnian League 6 and in regional basketball league. It has also been determined how certain variables contribute to distinguishing winning from losing teams and which are variables that distinguish winning teams in two ranks of competition.

Data has been processed by software package *Statistica 12.0* on School of electrical engineering on Tuzla University.

### **Results and discussion**

#### *Descriptive statistics, results in Bosnian League 6 and regional basketball league*

The chapter for results and disquisition is made of 2 parts. First part refers to compared results of descriptive statistics between winning teams in Bosnian League 6 and regional basketball league in 6 indicators of situational effectiveness. Second part comprises results of discriminative analysis in 6 nonstandard indicators of situational effectiveness between winning and losing teams in Bosnian League 6 and regional basketball league. League winners are mostly distinguished by variables T B & T\_N. There is a much larger number of unsuccessful transition plays in regional league (6,25) than in Bosnian League 6 (3,83). Dominance of stronger teams in Bosnian League 6 is so strong that in a situation where one team is head and shoulders above other(s) it is difficult to stop transition offense and that is why there are less unsuccessful transition plays. Variable transition offense – unsuccessful includes situations, three point shot – unsuccessful, two point shot – unsuccessful and turnover (lost ball) in transition. The reason for larger number of unsuccessful transition plays in regional league for winning teams is in strong transition defense. Losing league teams are mostly distinguished by variable T\_U, then T\_N and P\_U. Transition offense – successful is variable that is less present for losing teams in Bosnian League 6 (9,57) than for losing teams in regional competition (12,70). In regional competition there is almost equal average number of successful transition plays for losing teams and winning teams, and that shows us again that it is not possible in such a strong competition to make a significant advantage in transition phase mainly because of strength of teams and smaller number of strong teams for defending the transition offensive play. In Bosnian League 6 that is not the case and losing teams make much smaller number of successful transition plays on offense than losing teams in regional competition. On this level of descriptive analysis, we can only confirm evident difference in quality of the game in 2 different competitions. One can also conclude that the quality of teams and game in Bosnian League 6 is not balanced and that small number of strong teams in regional competitions can dominate by their quality on transition offense and defense, while in regional league that is not possible.

Table 1: Results of comparison of winning teams in Bosnian League 6 and regional league in the field of 6 nonstandard variables.

| Variable                          | Mean    | Mean      | t-value | df | P              | Std.Dev | Std.Dev | F-ratio  | P            |
|-----------------------------------|---------|-----------|---------|----|----------------|---------|---------|----------|--------------|
|                                   | Bosnian | Good Year |         |    |                | Bosnian | GY      | variance | variance     |
| transition offense – success      | 13.27   | 12.95     | 0.34    | 48 | 0.73465        | 3.46    | 2.80    | 1.53     | 0.345        |
| transition offense – unsuccessful | 3.83    | 6.25      | -3.56   | 48 | <b>0.00086</b> | 2.04    | 2.77    | 1.85     | 0.131        |
| transition offense – neutral      | 1.53    | 3.35      | -4.40   | 48 | <b>0.00007</b> | 1.17    | 1.76    | 2.26     | <b>0.046</b> |
| set offense – successful          | 29.40   | 30.05     | -0.62   | 48 | 0.53596        | 3.89    | 3.14    | 1.54     | 0.330        |
| set offense – unsuccessful        | 25.10   | 24.25     | 0.76    | 48 | 0.45220        | 4.45    | 2.81    | 2.51     | <b>0.039</b> |
| set offense – neutral             | 10.73   | 11.00     | -0.26   | 48 | 0.79918        | 3.62    | 3.60    | 1.01     | 1.000        |

Table 2: Results of comparison of losing teams in Bosnian League 6 and regional league in the field of 6 nonstandard variables.

| Variable                          | Mean    | Mean      | t-value | df | p       | Std.Dev | Std.Dev | F-ratio  | P        |
|-----------------------------------|---------|-----------|---------|----|---------|---------|---------|----------|----------|
|                                   | Bosnian | Good Year |         |    |         | Bosnian | GY      | variance | variance |
| transition offense – success      | 9.57    | 12.70     | -3.820  | 48 | 0.00038 | 2.73    | 3.01    | 1.22     | 0.614    |
| transition offense – unsuccessful | 5.17    | 6.65      | -1.890  | 48 | 0.06478 | 3.06    | 2.08    | 2.16     | 0.084    |
| transition offense – neutral      | 2.27    | 3.30      | -2.557  | 48 | 0.01377 | 1.31    | 1.53    | 1.35     | 0.452    |
| set offense – successful          | 26.53   | 25.20     | 1.091   | 48 | 0.28082 | 4.88    | 3.00    | 2.64     | 0.031    |
| set offense – unsuccessful        | 29.07   | 31.20     | -1.694  | 48 | 0.09667 | 4.39    | 4.31    | 1.04     | 0.952    |
| set offense – neutral             | 12.90   | 11.25     | 1.723   | 48 | 0.09139 | 3.42    | 3.16    | 1.17     | 0.734    |

### Discriminative analysis of Bosnian League 6 and regional basketball league

When the number of groups is limited to 2, and at the same time larger number of variables is analyzed as in our case, one simple method of discriminative analysis is used – Fisher's linear discriminative analysis. Distinctive values of discriminative function and canonical correlation are given in table 3. Large distinctive value has been calculated

and the value of correlation is large as well, 0.717, which definitely shows that 6 adopted indicators of situational effectiveness are very good in distinguishing successful from unsuccessful teams in Bosnian League 6. Results in table 3 also prove statistically significant discriminative function by Wilks'  $\lambda$  and Bartlett's  $\chi^2$  – test. The value of Wilks' test is obviously small, and  $\chi^2$  – test shows significance -0.00000052, which is much smaller than  $p=0.01$ .

Table 3: Bosnian League 6. Distinctive values of discriminative function and test of significance of function by Wilks and  $\chi^2$  – test.

| Function | Eigenvalue | Canonical Correlation | Wilks' Lambda | Chi-square | Df | Sig.    |
|----------|------------|-----------------------|---------------|------------|----|---------|
| 1        | 1.057      | 0.717                 | 0.486         | 39.672     | 6  | 0.00000 |

Tabela 4: Regional league. Distinctive values of discriminative function and test of significance of discriminative function by Wilks and  $\chi^2$  – test.

| Function | Eigenvalue | Canonical Correlation | Wilks' Lambda | Chi-square | Df | Sig.    |
|----------|------------|-----------------------|---------------|------------|----|---------|
| 1        | 2.102      | 0.823                 | 0.322         | 39.623     | 6  | 0.00000 |

Table 5: Correlations between certain variables and discriminative function.  
(Pooled within-groups correlations between discriminating variables and standardized canonical discriminative functions - \* Variables ordered by absolute size of correlation within function.)

| Structure matrix                  |            |                                   |            |
|-----------------------------------|------------|-----------------------------------|------------|
| Bosnian League 6                  |            | Regional league                   |            |
| Var                               | Function 1 | Var                               | Function 1 |
| transition offense – success      | -0.59      | set offense – unsuccessful        | 0.68       |
| set offense – unsuccessful        | 0.44       | set offense – successful          | -0.56      |
| set offense – successful          | -0.32      | transition offense – unsuccessful | 0.06       |
| set offense – neutral             | 0.30       | transition offense – success      | -0.03      |
| transition offense – neutral      | 0.29       | set offense – neutral             | 0.03       |
| transition offense – unsuccessful | 0.25       | transition offense – neutral      | -0.01      |

Table 4 gives distinctive values of discriminative function and canonical correlation. Very large distinctive value was calculated as well as the value of correlation which is extremely large which shows that 6 adopted indicators of situational effectiveness are very good in distinguishing successful from unsuccessful teams in regional basketball league. The value is larger from those calculated through some other ways of research.

Table 4 proves statistical significance of the importance of discriminative function by Wilks X and Burtlett  $\chi^2$  – test. The value calculated by Wilks test is obviously small, and  $\chi^2$  – test shows significance of 0.00000054, which is much smaller than  $p=0.01$ . Results presented in table 5 point to influence of certain variables and to their discriminative power compared to game outcome. We can see in the table that in Bosnian League 6 the largest correlation with standardized coefficient of canonic discriminative function has following variables: transition – successful and position – unsuccessful, and other variables have to some extent smaller correlation. Successful transition offensive play is the one with the largest coefficient of correlation with discriminative function. Bosnian League 6 for the champion of Bosnia and Herzegovina is the league with small number of strong teams (strong teams are mostly 2 teams that at the same season play in regional league as well) who are head and shoulders above other teams very early in the season and who dominate with their quality defense which ignites fast break that leads to successful offense. In the part of the table where the results from regional basketball league are presented, the largest correlation with discriminative function among 6 variables has variable set offense unsuccessful (0.68).

Set offense unsuccessful and successful (0.56) are variables that mostly influence discrimination of winning from losing teams. Regional basketball league has high quality where the effectiveness of set offensive play is dominant in distinguishing winning from losing teams.

One of the reasons is also that such strong teams are capable to use their strong defense to stop transition offense which can lead to easy points. On the other hand, win through set plays is also determined by level of defense which is very strong in this rank of basketball competition.

### Conclusion

Results of discriminative analysis give us the right to discriminate winning from losing teams on the basis of 6 selected variables. The use of discriminative analysis and significance of discrimination completely justify choice of this method in data processing. We came up with very large distinctive value of discriminative function in scores from Bosnian League 6, and correlation value is high, 0.717, which definitely shows that 6 approved indicators of situational effectiveness are very good in distinguishing successful from unsuccessful teams. Statistical significance of discriminative function by Wilks and Burtlett  $\chi^2$  has also been confirmed. Wilks test showed very small value and  $\chi^2$  test showed significance of 0.00000052, which is much less than  $p = 0.01$ . The largest correlation with standardized coefficients of canonic discriminative function has variable: transition – successful. It has been determined that winning and losing teams can also be discriminated in terms of quality regional basketball league.

Calculated canonic correlation is 0.823 and the level of significance is 0.00000053, which is therefore under 0.01. Variables that influence discriminative function the most are set play – unsuccessful and set play – successful. Unlike Bosnian League 6, in regional league variables from set offensive play more distinguish winning from losing teams which can be explained with technical, tactical and physical counterbalance of teams in regional league that are strong enough to

stop transition offensive play, having in mind its effectiveness. The results confirm obvious difference in quality of the game in these two competitions. By balancing strong teams in Bosnian League 6 we could expect that successfulness in this competition differentiates based on effectiveness in performing set play offense, just like this research established that the same case is currently in regional basketball league.

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## NESTANDARDNI INDIKATORI NAPADAČKE EFIKASNOSTI U KOŠARCI I USPJEŠNOSTI KOŠARKAŠKIH EKIPA

### Sažetak

Analiza nestandardnih indikatora napadačke efikasnosti primjenjena je u istraživačkom projektu koji je uključivao 50 utakmica "Bosanske lige 6" i regionalne "Goodyear Basketball League" (sada poznate kao NLB Liga). Ovaj naučni članak, uz pomoć diskriminativne analize nestandardnih indikatora, pokazao je koje varijable razdvajaju pobjedničke ekipe od poraženih u Bosanskoj ligi 6 i Regionalnoj NLB ligi, kao i koje varijable dijele pobjednike od poraženih ekipa u dva različita takmičarska ranga.

**Key words:** uspješnost, košarka, pobjeda, situacijski indikatori, diskriminativna analiza, Bosanska Liga 6, regionalna košarkaška liga, tranzicijska odbrana i postavljeni napad

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## PANEURHYTHMY AND EURHYTHMY – PHILOSOPHY AND PRACTICE

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*Professional paper*

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### Abstract

*The paper acquaints with paneurhythmy. It is a Bulgarian kind of gymnastics, dance or method introduced by Peter Deunov (the Master Beinsa Douno) in the first half of XX century. Some authors determine paneurhythmy as a science as well: "science of the harmonious, conscious movement, based upon the laws of the Living Nature". Translation of the term means "Supreme Cosmic Rhythm". Paneurhythmy consists of a sequence of exercises, danced under music accompaniment with poetic text at the same time. Paneurhythmical gymnastic complex (=28 exercises or paneurhythmic forms) is fulfilled early in the morning from 22 March until 22 September for the people from the North Hemisphere. Logically for the people of the South Hemisphere it must be played from 22 September to 22 March. As paneurhythmy is already built and unchangeable system nobody has the right to introduce some changes in it. But in practice correct performance of exercises even nowadays leads to many heated debates. Contribution of this material is the spreading of the system, explanation of its philosophy, seeking its place in the school system. Another system precedes the Paneurhythmy and this is the system of Rudolf Steiner called Eurhythmy. The paper is also an attempt a comparative analysis between the two systems to be done.*

**Key words:** *paneurhythmic forms, comparative analysis*

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### Introduction

Since the dawn of humanity movements always have been an attractive centre of cognition. During the first half of XX century were founded two new scientific systems for physical activity of people. The name of the first system whose author is Rudolf Steiner is **eurhythmy**. The name of the second system is **paneurhythmy** and its author is Peter Deunov/Петър Дънов/Petar Dunov. Both systems are non-religious and enhance many Buddhist, Christian, Muslim, and other traditional knowledge by the special attention paid on the spiritual part of physical exercises.

### Methods and Results

The paper is based on the methods **retrospective/historical** and **comparative analyses**. The first comparison will be among the curriculums vitae of the two authors. We will start with Rudolf Steiner as he precedes Peter Deunov. **Rudolf Steiner** was born in 1861 in Murakiraly in Austro-Hungary (now Donji Kraljevec, Croatia). He died in Switzerland in 1925. In 1883 he graduated from the Technische Hochschule (Technical University) in Vienna, where he studied

mathematics, physics, and philosophy. In 1891 Rudolf Steiner earned a doctorate in philosophy at the University of Rostock in Germany. Steiner is defined as a philosopher, literacy scholar, educator, artist, playwright, social thinker, and esotericist. He was the founder of Anthroposophy, Waldorf education, biodynamic agriculture, anthroposophical medicine, and the new form of movement art named Eurhythmy. Rudolf Steiner is author of almost 30 books. He also gave approximately 6000 lectures on a wide range of subjects. The complete edition of his published works numbers over 330 volumes. They are with contribution to various areas.

**Peter Deunov**, the founder of paneurhythmy, was born in 1864 in the village of Nikolaevka near Varna in Bulgaria. He obtained his secondary school in Varna and his higher education in medicine and philosophy in the United States. He returned to his country after an absence of 8 years and engaged himself in systematic study of the phrenology of the Bulgarian people. Peter Deunov was also a musician and a composer of spiritual songs. Somewhere in 1918 he founded the so called "White brotherhood"

and turned to spiritual deeds to preach his views and understandings. Meanwhile somewhere at the 20s of XX century he started to show and play his first exercises of Paneurhythmy. Peter Deunov is author of totally 184 books, containing his lectures and musical works. They were published from 1896 to 1948. He died in 1944. The second comparison will be over the philosophic views of the two eminent scholars.

**Rudolf Steiner's Views and Understandings:** As a founder of anthroposophy he describes it as "a path of knowledge, to guide the spiritual in the human being to the spiritual in the universe... Anthroposophists are those who experience, as an essential need of life, certain questions on the nature of the human being and the universe, just as one experiences hunger and thirst" (1924). Steiner worked in the realm of consciousness and cognition. He had techniques for the development of awareness to nature's cycles, daily meditations and concentration practices, about which he thought will lead to clear critical thinking, so that the individuals will reach spiritual levels safely. Steiner was completely sure that working along with the spiritual worlds enriches the life of the individual and the world. He called anthroposophy "this science of spirit", meaning also "wisdom of human being". Rudolf Steiner derived his understandings from Johann Wolfgang Goethe's views where "thinking is no more and no less an organ of perception than the eye or ear. Just as the eye perceives colors and the ear sounds, so thinking perceives ideas" (R. Steiner, 1883).

**Peter Deunov's Views and Understandings:** The fundamental principles of his teaching are Love, Wisdom and Truth. "There is nothing greater than these principles; there is no straighter or surer path. In these three principles lies the salvation of the world." and "Love brings life. Wisdom brings knowledge and light which help in the study of the Laws of Nature. Truth shining within the soul brings freedom from all weakness and vice." The third comparison will be on the nature of the two sciences or movement arts.

**Eurhythmy** appears in 1911 and earlier than paneurhythmy. Eurhythmy is a movement art originated by Rudolf Steiner in conjunction with his wife Marie von Sivers. Primarily it was a performance art but later on it was

used in education, especially in Waldorf schools and as a movement therapy. The word "eurhythmy" has Greek roots and means beautiful or harmonious rhythm. Aim of eurhythmy is "to bring the artists' expressive movement and both the performer's and audience's feeling experience into harmony with a piece of content". Sometimes eurhythmy is called "visible music" or "visible speech".

For Rudolf Steiner it will always be "art of the soul". Further views are: "Movement is life's signature, its own language. Every moment we breathe is filled with pulse...rhythm. It permeates the substance we are made of. Physical form is built out of movement come to rest. So, too, our feelings, thoughts, and inspirations have gestures that are matched in the forms we find in the world. It is one of the great mysteries that inner experiences and outer form come from the same source. Recognition of this connection sits just beyond our consciousness. Yet, we develop it to make our way through life. We learn to read the world and other people through the language of movements ... alongside the language of sounds. Form – Movement – Language all "sounds" the essential nature of the world in different ways. *Eurhythmy is a movement art that brings all three together.* It gives expression to the whole voice of the human being and the world language, through movement, color and form. When this integration takes place through eurhythmy, the spiritual nature behind each living thing begins to have a clear voice, a visible reality."

Eurhythmy is also a tool of anthroposophy, used to reveal and bring about a certain "spiritual impulse". When a child practices eurhythmy, it practices an art form, designed to elicit a special spiritual impulse in it and in the others. While we practice eurhythmy we have to support the dialogue between audience and performers. Eurhythmy is made up of different movements that represent various phonetic sounds. Eurhythmy is very often compared to modern dance, martial arts (e.g. tai-chi), physical therapy, and performance art but eurhythmy is none of these things. Nowadays there are many training centres and artistic ensembles in many countries.

**Paneurhythmy** appeared in 1927 but some of its exercises (e.g. "The sun rises") were played still in 1922. The whole book was published in 1938.

Its author the Master Peter Deunov/Beinsa Douno states: "PanEuRhythmy is the key to my teaching which brings peace to human souls. The Great Souls must receive this key from you: you must give it to them, so that they can open the door and offer a helping hand to souls still plunged in the world of oblivion."

The consciousness of these beings will be illuminated, and they will grasp the meaning of their life. The Great evolved Souls will implant in them the graft of Love, and this world, granted from within, will acquire a new light and a new impulse towards all other aspirations: from involution to evolution; from unending wars towards eternal peace; from hatred towards Divine Love; from egoism towards self-abnegation."

The fundamental principles of the teaching of Peter Deunov are Love, Wisdom and Truth. Paneurhythmy is a sacred dance. The word paneurhythmy means "supreme cosmic rhythm" (pan = whole, all over, cosmic; eu=true, supreme, the essence from which everything arises; rhythm=periodicity, correct regularity of movement). Each exercise of paneurhythmy has a symbolic significance and expresses a particular thought, feeling and action. The dancing circle is a symbol of the great wheel of life and the way of human consciousness towards perfection.

Paneurhythmy imposes physical, emotional, mental and spiritual health. Exercises increase the capacity of the organs and regularize their functions. They stimulate the awakening and development of the spiritual gifts such as mercy, compassion, love, faith and hope. Furthermore, this sacred dance develops the musical capacity and sensitivity. It promotes expansion of consciousness and has a very strong curative power.

"The effect of Paneurhythmy on people is enormous and many-sided. It influences physical development. The movements are smooth and graceful, all parts of the body participate. Breathing and circulation are

improved. The nervous system is strengthened, too.

Paneurhythmy serves as a real, concrete and, at the same time a beautiful method for physical renewal and for the strengthening of mind, emotions and will." "These exercises should be performed in the school and in the community in order to prepare a completely new generation with a physical health and endurance, with noble thoughts, spiritual progress, strong will power and initiative."

Through them people can be trained physically and spiritually to a new creativeness. Firstly, one should learn the basic movements and then to proceed to the more complicated. One has to spend at least 10 to 15 minutes a day for exercise. "There are movements that develop the mind; others – the heart; and still others – the hands while exercising."

One of the most practical aspects of Peter Deunov's teaching is the practice of dance outdoor in harmony with God and Nature. Special attention is paid to the Sun. Music as a means of harmonizing the human spirit is also a key to practice the circle of joy. Nowadays there are many centres to study paneurhythmy not only in Bulgaria but also in the USA (San Francisco, St .Louis and Chicago), Russia, Germany, etc. For the purpose the texts of the songs are translated in English. The preferred instruments for the music to be played are the violins. Obligatory demand is the white color of the clothes. In eurhythmy colors are different and correspond to the idea of the movements.

## Conclusion

Undoubtedly both systems Eurhythmy and Paneurhythmy have their well-proved virtues. It is more than good for them to find their place at schools. As physical education programmes are already occupied, the best place for them will be as outdoor activities. Enthusiasts and teachers are needed too.

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## PANEURITMIJA I EURITMIJA – FILOZOFIJA I PRAKSA

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### Sažetak

Ovaj članak se bavi paneuritmijom. To je bugarska vrsta gimnastike, plesa ili metode predstavljene od Petera Deunova (the Master Beinsa Douno) u prvoj polovini XX vijeka. Neki autori određuju paneuritmiju i kao nauku: "zbog harmoničnih, svjesnih gibanja, utemeljenih na zakonima Žive prirode". Prevod ovog termina znači "Vrhovni Svemirski Ritam". Paneuritmija se sastoji od sekvenci vježbi, plesanih pod pratnjom muzike s poetskim tekstom istovremeno. Paneuritmiki gimnastički kompleks (=28 vježi ili paneuritmičkih formi) se koristi rano ujutro od 22. marta do 22. septembra kod ljudi na sjevernoj hemisferi. Logično, ljudi na južnoj hemisferi trebaju "igrati" od 22. septembra do 22. marta. Budući je paneuritmija već izgrađena kao nepromjenjiv sistem niko nema pravo predstaviti neke promjene unutar nje. Međutim, u praksi, pravilno izvođenje vježbi čak i u današnje vrijeme vodi do mnogih žestokih debata. Doprinos ovog materijala je u širenju sistema, objašnjenju filozofije, traženja prostora u školskom sistemu. Jedan drugi sistem je prethodio paneuritmiji, a to je sistem Rudolfa Steinera zvan Euritmija. Ovaj članak također pravi komparativnu analizu između ta dva sistema.

**Key words:** paneuritmijske forme, komparativna analiza

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## HISTORY OF RULE CHANGES IN WATER POLO

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*Review paper*

### **Abstract**

*The modern water polo has very few similarities to the game originally introduced in England. In the course of its centennial history almost every aspect of the game has changed. The duration of the periods, as well as their number, the quantity of team members, the attacking time and exclusions and many other aspects have gradually evolved giving the modern water polo a totally different appearance. Significant improvements have also been made concerning the general preparation of the athletes. In general, the evolution of water polo game is a long process that still goes on. The main goal of this study was to systemize the major changes in the game's history.*

**Key words:** water polo, history, game rules

### **Introduction**

The water polo game has a long history that goes back to the mid 19th century. It first started in England, to be accepted and enhanced later by the Scottish so at the beginning of 20th century it became popular across Atlantic Ocean as well, and then across the globe. Men's water polo was the among the first team sports introduced at the modern Olympic games in 1900.

Today water polo is being played in many countries in several age categories, the players are both male and female, and it is considered to be one of the most demanding sports when it comes to physical and psychological aspects of the game.

Modern water polo has very little in common with the original game that originates from England. In a more than 100 years long history almost every aspect of this game has changed. Change of the duration time and the number of playing periods (quarters), the number of players, attack time and exclusion time as well as many other aspects lead to the fact that the modern water polo differs greatly from the one in the past.

Significant rule changes had a great influence on the general players' training. The evolution of water polo is a very long process that still goes on. The main purpose of this work is chronological systematization of main changes in the history of water polo game.

*First period – game onset and its forming (1869-1876)*

1869. - The game dates from mid 19th century Eastern India where the officers of colonial corpus decided while playing polo to experiment with a similar team water sport.



Picture 1. «Water Polo» (30)

Around 1869. the game was transferred to England and it soon became widely known. At this early stage of its development water polo first borrows the rules from rugby and after from football as well, and it is played for fun in lakes and rivers. The first "ball" used was a pig bladder which was soon replaced by a rubber ball.

1870. - London swimming club creates first set of 11 rules for the "water football". These rules are general and not obligatory. They tolerate rough and static play instead of techniques and speed.



Picture 2. «Water football» (20)

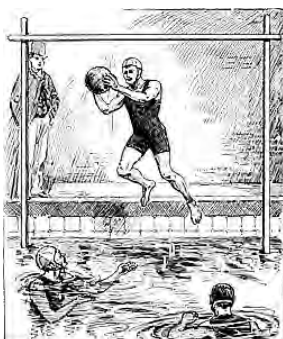
*Second period – creation of unique rules and their use at the international level (1877-1907)*

1877. - a serious progress in the game development was noted when William Wilson presented the first written rules for “water football” in Glasgow –Scotland.



Picture 3. William Wilson (18)

1879. - A goal similar to the football one was used for the first time in water polo game. The dimensions of the playing field were determined and the recommended number of players was 9.



Picture 4. Goal in Wilson's rules

1880. - The game is played in Scotland as well and by performing the “trudgen” style, many changes are being introduced in the rulebook as well as the complete form of water polo.

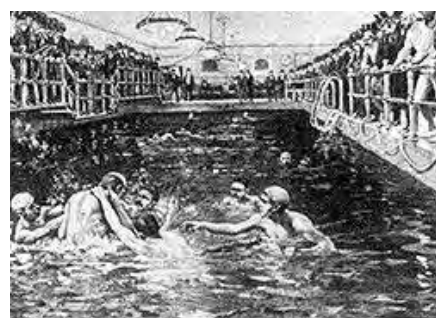
There is a general tendency toward speeding up the motion and using several technical ways of managing the game, replacing static duels.

1883. - The game lasts 8 minutes.

1884. - The New Britain's swimming association officially recognizes the new game named “water football”. The number of players is down to 8. The goal measuring 10ft: 3ft is obligatory, and a shot is considered valid only if the ball entered the goal.

1886. - The number of players is down to 7. The drafting committee, which consisted of four members, changed the game rules. The projects imply that the playing field is 30 yd long and not less than 20 yd wide. The goal dimensions are obligatory (10ft: 3ft), and the players are forbidden to step the bottom of the pool during the game. All English clubs unanimously accepted represented reports and recommendations to change the rules. The first officially documented championship is held, where the “Berto” team won the final game against “Otar” with 3:0. John Robinson, ex member of the Lankshear club and a swimming instructor organizes the first water polo team in the USA under the aegis of the Boston Athlete Association.

1890. -London's water polo league is founded. 28/07- the Scottish play against the Kensington team and win 4:0 relaying mainly on the fast team combinations with the ball instead of static dribbling. The first American water polo championship is held, the winner is Sidnam swimming club.



Picture 5. The American version of water polo game (25)

1891. - the first encounter at the academic level was held between the Cambridge and Oxford Universities, Oxford beats Cambridge with 4:1 and repeats the success next year- 5:1.



Picture 6. Illustrations from the matches Oxford and Cambridge in 1891 and 1906 (30)

1893. - The game spreads in Germany

1894. - Water polo is being played in Austria

1895. - France and Belgium join the countries that develop the new game.

1897. - The game is widely known and popular in Hungary too

1900. - Water polo is part of the program of the second Olympic Games in Paris as a demonstration sport. The participants of this first Olympic tournament are the teams from Great Britain, Belgium and France, while British win Belgians in the finals with 7:2. The game becomes popular in Italy as well.

1904. - At the third Olympic Games in Saint Luis the water polo tournament is held according to American rules. Therefore the German national team, who wanted to take part in it, cancelled its participation and the only teams fighting for the title are the American ones. The gold medal is won by New York athlete club who played better in the finals against the team of Chicago athlete association.

1905. - Splashing the water in opponent's face and hitting the ball with the fist is added on the list of fouls.

1907. - Water polo enters the ex Yugoslavia with Sombor Sport Association introducing it in its program of activities.



Picture 7 -detail from the Olympics in Saint Luis 1904 (30)

*Third period – creating international structures that manage the game development (1908-1969)*

1908. - 19/07 International Swimming Federation (Federation Internationale de Natation-FINA) is founded in London.



Picture 8. FINA & LEN Logos (19,22)

1912. - First national water polo championship in Germany.

1918. -Rules regarding the free throw had changed: according to the new text the only player who can make the throw is the one closest to the place where the foul was made.

1919. - Detailed description of a way in which a free throw should be done.

1926. - LEN - Ligue Européenne de Natation was founded.

1928. - The measuring of the playing field in yards was predetermined and disobeying the referee's decisions enters the list of fouls.

1929. - During the 11th FINA congress International water Polo Board (IWPB) was founded. It consists of four British representatives and four FINA members, and its purpose is to create a unique set of rules that makes the game more dynamic and gives better results. This set of rules would come into force on 01/01/1930.

1932. - IWPB allocates the fouls into 3 subgroups; ordinary foul, major foul, foul sanctioned by banning from the play and a penalty throw. Dimensions of the playing field are fixed to 30m length and 20m width. The ball weight has been determined as well, for the first time. It is between 400g and 450 g, which is more than the one previously used-360g-420g.

1936. - James Smith, a coach from California and an author of several books on water polo suggests the use of a synthetic rubber-coated ball, which is more durable and makes the navigation easier.

1938.- Splashing the opponent in the face in a 4 m zone enters the list of major fouls sanctioned by banning from the play and penalty throw.

1942.- A new rule has been introduced by which it is allowed to shoot at the goal directly from a free throw, if a free throw has been assigned outside of 4 m zone as a result of a major foul.

1949. - After the London Olympics IWPB suggests introducing "South-American" rules on experimental basis that allow players to move while the time is stopped. The rule that allows shooting at the goal after a major foul committed outside the 4 m zone has been changed.

1952. - The game rules have an additional line- every referee's decision is final.

1956. - The beginning of the game from de center after the shot has been introduced, and every action inside the 4 m zone that interferes with shooting at the goal is considered major foul that leads to a penalty shot.

1961. - The game duration changes: 4 periods, 5 min each, without break.

1967. - For the sake of maintaining the equal number of players in both teams, a new rule was introduced which says that when a major foul is committed the team of the player who committed it gets a penalty point. 3 penalty points lead to a four-meter line penalty shot in favor of the opposite team. FINA adds to the competition rulebook the illustrations of most common fouls in the interest of easier understanding the rules' logic.

#### *Fourth period – the game's development worldwide*

1970. - The penalty points system is replaced by a new one -personal fouls system.

1971. - one-minute penalty is introduced for committing a major foul.

1975. - IWPB recommends the use of caps with plastic ear protectors.

1977. -The attack time is reduced to 35 sec. The duration of exclusion due to a major foul is down to 45 sec. Two referees control game.

1981. - A unified referees' sign system was introduced. The number of players is up to 13 (7 playing and 6 in reserve). The game duration is increased to 4 quarters, 7 minutes each.

1984. - During the FINA congress in Los Angeles, the committee suggests two new rules: To allow an obligatory replacement of the excluded player by his teammate who would enter the game in the indicated zone i.e. Penalty area. To forbid the player who stands with his back turned to the opponent's goal, and who "earned" a free throw, to continue holding that position after he finishes throwing the ball. Both suggestions were dismissed.

1986. - FINA technical congress was held in Madrid during which following decisions in changing the game rules were made: The exclusion time is down to 35sec. Receiving three personal fouls (ordinary fouls mostly committed by central defense players) puts the player on the bench the remainder of the match. Attack fouls are no longer sanctioned with a penalty point after a free throw.



Picture 9. A detail from World Championship in Madrid 1986 (30)

1991. - During the FINA congress in Perth, Australia, a decision has been made to cut down the exclusion time to 20 sec. Also, a goalkeeper is permitted to throw the ball in the direction of the opponent's goal but he is not allowed to go behind the central line of the playing field. If at the moment the playing time runs out the ball flies across the field and enters the goal the shot counts as valid.

1994. - During the FINA congress in Rio de Janeiro, technical committee gives 8 suggestions for changing the game rules: Reducing the playing field (25m: 16m), Cutting down the number of players to 6, Using a smaller ball, Obligatory entrance of an excluded player (after reaching the 2 m penalty area). Allow the replacements to be made at any time in a regulated sequence, Introducing 7 m zone outside which free throws can be performed directly towards the goal, Replacement of flags by the referees, Coaches have 2 technical time-outs, which they can ask for at any time when their team is in position of the ball. The purpose of these suggestions is greater game's dynamics and attractiveness for viewers. For the same reason, no more limitation in performing a free throw from the place of the foul when the ball is further away from the goal than the place of the foul itself. In the matches where it is necessary to have a winner, a rule of "golden goal" has been introduced- the third match's extra period ends after the shot has been scored by either parties.

1994. - During FINA technical congress in Rome a decision has been made to use the new suggestions experimentally at the World Junior Championship in Dunkirk 1995.

1996. - Ad hoc FINA congress held in Berlin during the pre-Olympic water polo tournament dismisses the first four suggestions accepting the rest of them, and the decision enters the force subsequent to Atlanta Olympics held that same year.



Picture 10. Water polo referee (24)

2005- New rule changes have been made during the FINA congress in Montreal. The changes were following: 1) The dimensions of the playing field were precisely determined for official matches- 30m: 25m for men and 25m: 20 m for women. 2) The match duration is up to 8 minutes each quarter, and the break time between the third and the fourth quarter is 5 minutes. 3) The 3rd technical break is introduced; it can be used only in extra-time, 4) The attack time is down to 30 sec. 5) 4m and 7 m lines cease to exist, instead a 5 m line is introduced and all the rules applying to them, remain for 5 m one. 6) The last game element that implies using both hands, blocking the shot towards the goal is treated as a foul. 7) The rule for obtaining a winner (when necessary) by shooting a "golden goal" in the third extra-time period has been changed; shooting penalty shots are being used instead.



Picture 11 Preparing to shoot outside the 5 m zone (a detail from European Championship in Belgrade 2006) (22)

### ***(Instead of) Conclusion***

Even in so many different ways, the following factors had a strong influence onto the development of the game: Water polo competition rulebook – accepting unified rules and its change during several development periods; Technical changes- modern technical equipment, precise time-measuring systems, using video equipment, enhancing the quality of sport team spirit;

Commercialization and introduction of mass media, meaning proportionally bigger profit. Factors mentioned have a great deal of influence on the competition character within a sport duel and therefore influence greatly the tactical doctrine on the long run. In order to make this interpretation more comprehensible, we should point out that mentioned periods possess more or less inner

variability (based on which many authors differentiate a much greater number of game development periods), which stands out in dominating different offense and defence game styles through out the years. There is a series of changes within every period which final purpose is to equalise the competition rules with real situations.

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## HISTORIJA PROMJENA PRAVILA U VATERPOLU

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### Sažetak

*Moderni vaterpolo ima malo sličnosti sa izvornom igrom koja se pojavila u Engleskoj. U toku historije, više od stoljeća, gotovo je svaki aspekt ovog sporta promijenjen. Promjena trajanja i broj perioda (četvrtina), broj igrača u timu, vrijeme napada i isključenja, kao i mnogi drugi aspekti postepeno su doveli do toga da moderni vaterpolo bude potpuno drugačiji u odnosu na početke. Značajne promjene pravila su imale značajan uticaj na opću pripremu igrača. Evolucija vaterpolo igre je veoma dug proces koji se odvija i danas. Glavni cilj rada je hronološka sistematizacija glavnih promjena u historiji vaterpolo igre.*

**Ključne riječi:** vaterpolo, historija, pravila igre

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## **CORRELATIONS BETWEEN THE GENERIC SEGMENT OF STRUCTURE AND NUMBER OF OFFICIALLY HELD SPORTING MANIFESTATIONS IN TEAM-SPORTS AND THE BUSINESS AND SPORTING ACHIEVEMENTS**

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### **Summary**

*Quality issue of the pure (primary) sporting product and of the service, as well as its reflections on the success of the sporting organisations, has a critical influence. In the sporting industry, especially when talking about the competitive sports, and more than in any other industry, the sporting product quality, and especially the primary product quality (pure sporting product), is very clear and measurable in terms of the realised sporting and business achievements. The purpose of this research work is to objectify the potentials and the attractiveness of the primary sporting product in the following team-sports: football, basketball, volleyball, and team-handball from the Canton of Sarajevo for the competitive 2003/04 season, based on the conducted correlation analyses of the generically significant structure and number of officially held sporting manifestations segment and the business and sporting achievements. By observing the significance of the primary sporting product within team-sports, reflected in the generic structure and number of officially held sporting manifestations segment and its correlation with the business and sporting achievements, it is possible to quantify the successful management of the sporting organisations focused on the sustainable development in terms of the selection of the generic strategies with a clear accent on the fact that only the „efficacy“ of the sporting achievement implies the „quality“ of the business achievement.*

**Key words:** correlation, sporting manifestations, business and sporting achievements.

### **Background**

Competitiveness with the quality and the attractiveness of the sporting products (primary and complementary) at the market is the main definition of the mission and the success of individual industries, and of the sporting industry, as well. Based on the generally accepted industrial forces analysis conception, developed by Michael Porter in the 80s of the twentieth century, it is possible to present a model analysis of the correlations between the significant generic segments in team-sports and the business and sporting achievements and, in that way, to indicate the effects of the structural industrial forces in sports. Based on such conception, innovated on the sporting management principles, this research analysed the potentials of the sporting organisations in team-sports, such as football, basketball, volleyball, and team-handball from the Canton of Sarajevo for the competitive 2003/04 season from the aspect of providing the “contemporary production”, which involves a complete reproduction cycle, from the idea to the product, which develops the prerequisites for the sustainable development at the market. This approach is especially related to the high quality

sporting game that, by its attractiveness, but also with the sporting outcome, satisfies the end user. This production cycle is also related to the production of young and talented sportspersons who in later stages become the “national stars”, that is, the products “without a fault”. This provides one of the most significant conditions, which is a demand of new products and services condition and provides a sustainable development at the sporting market. According to Bartoluci M., (1997), pages 235-236. “Competitive top-quality sports is a pure sporting product that involves sporting manifestations of all sorts and ranks of competition”, and in this research work the generic structure and number of officially held sporting manifestations segment is equally treated as a primary sporting product.

### **Problem and purpose of this research**

This research presents the correlations between the generically significant structure and number of officially held sporting manifestations segment in the sports, such as football, basketball, volleyball and team-handball from the Canton of Sarajevo, and the business and sporting achievements

segment at the Canton of Sarajevo level, and rationalises the conditions for the performance at the market programme application with an accent on the sporting product quality as a prerequisite for its successful positioning at the market. The purpose of this research was related to the success analysis of the sporting organisations in team-sports (football, basketball clubs, volleyball, and team-handball) from the Canton of Sarajevo for the competitive 2003/04 season, in terms of a selection of the generic strategies and their objectification, based on the outcomes of the correlation analysis of the generically significant structure and number of officially held sporting manifestations segment and the business and sporting achievements.

### Methods

The sample of respondents for the needs of this research is defined as the cluster of 62 analysed sporting clubs in team-sports, such as, football, basketball, volleyball, and team-handball, from the Canton of Sarajevo in the competitive 2003/04 season. This work required the analyses of the following 10 criteria variables of the generically significant structure and number of officially held sporting manifestations segment, and which are as follows: number of officially held sporting manifestations – senior category-men (OFFICMAN); number of officially held sporting manifestations – senior category-women (OFFICMANSW); number of officially held sporting manifestations – junior category-men (OFFICMANJM); number of officially held sporting manifestations – junior category-women (OFFICMANJW); number of officially held sporting manifestations – cadet category-men (OFFICMANCM); number of officially held sporting manifestations – cadet category-women (OFFICMANCW); total number of officially held sporting manifestations – senior category (TOTOFFMAN); average attendance by a single official competition on the home field (ATTENDAN); business achievement (BUSACHI); and sporting achievement (SPACHI).

To objectify the research outcomes, this research used a non-parametric computing procedure called the Spearman's rank-correlations (Ro-correlation coefficient). In this research we presented the reviews of the listed values that are the outcomes of the statistical processing and the inferences analysed in the SPSS software programme. Based on this statistical package, we presented the reviews of the Spearman's correlation coefficients values, as well as

their levels of significance in testing the correlations between the business and sporting achievements and the other criteria variables.

### Research outcomes and discussion

#### a) *Correlation between the segment officially held sporting manifestations and the business and sporting achievements in football*

Number of officially held sporting manifestations segment represent a primary sporting product variable, which is related to the number of officially held sporting competitions in the senior competition category men and women, and a variable which is related to the official sporting manifestations in the competition of juniors and cadets, category men and women. Definition of Spearman's non-parametric correlation coefficients shows the analysis of the correlation between the structure and number of the officially held sporting manifestations segment and the business and sporting achievement variables in football for the 2003/04 season, in Table 1.

Based on the outcomes presented in Table 1, this research verified the statistically significant correlation between the business achievement variable (BUSACHI) and the following variables: number of officially held sporting manifestations in the senior competition – men (OFFICMAN); number of officially held sporting manifestations in the senior competition – women (OFFICMANSW); total number of officially held sporting manifestations in the category of seniors – men and women (TOTOFFMAN), as well as, the average attendance by a single official competition on the home field variable (ATTENDAN). Sporting achievement variable (SPACHI) has a statistically significant correlation with the following variables: number of officially held sporting manifestations in the senior competition – men (OFFICMAN); number of officially held sporting manifestations in the senior competition – juniors-men (OFFICMANJM); number of officially held sporting manifestations in the competition of cadets-men (OFFICMANCM); total number of officially held sporting manifestations in the category of seniors – men and women (TOTOFFMAN); and with the average attendance by a single official competition on the home field variable (ATTENDAN).

**Table 1.** Correlation between the business and sporting achievements variable and primary sporting product variable in football for the 2003/04 season.

| Football   | BUS  |      |    | SPA  |      |    |
|------------|------|------|----|------|------|----|
|            | R    | P    | N  | R    | P    | N  |
| OFFICMAN   | 0.45 | 0.02 | 27 | 0.59 | 0.00 | 27 |
| OFFICMANSW | -    | 0.70 | 27 | 0.32 | 0.11 | 27 |
| OFFICMANJM | 0.37 | 0.06 | 27 | 0.61 | 0.00 | 27 |
| OFFICMANJW | 0.00 | 0.00 | 27 | 0.00 | 0.00 | 27 |
| OFFICMANCM | 0.22 | 0.26 | 27 | 0.57 | 0.00 | 27 |
| OFFICMANCW | 0.00 | 0.00 | 27 | 0.00 | 0.00 | 27 |
| TOTOFFMAN  | 0.45 | 0.02 | 27 | 0.70 | 0.00 | 27 |
| ATTENDAN   | 0.42 | 0.03 | 27 | 0.57 | 0.00 | 27 |
| BUSACHI    | 1.00 | 0.00 | 27 | 0.45 | 0.02 | 27 |
| SPACHI     | 0.02 | 0.02 | 27 | 1.00 | 0.00 | 27 |

The analyses conducted also verified the statistically significant correlation between the business achievement variable (BUSACHI) and the sporting achievement variable (SPACHI). Based on the outcomes of the statistically significant correlation coefficients of the structure and number of officially held sporting manifestations variables in football, and which are as follows: number of officially held sporting manifestations in the senior competition – men (OFFICMAN); number of officially held sporting manifestations in the senior competition – women (OFFICMANSW); total number of officially held sporting manifestations in the senior category – men and women (TOTOFFMAN); as well as the average attendance by a single official competition on the home field variable (ATTENDAN), and the business achievement variable (BUSACHI), in the first case, and the outcomes of the statistically significant correlation coefficients of the structure and number of officially held sporting manifestations variables: number of officially held sporting manifestations in the senior competition – men (OFFICMAN); number of officially held sporting manifestations in the senior competition – juniors-men (OFFICMANJM); number of officially held sporting manifestations in the competition of – cadets-men (OFFICMANCM); total number of officially held sporting manifestations in the category of seniors – men and women (TOTOFFMAN); and the average attendance by a single official competition on the home field variable (ATTENDAN), and the sporting achievement variable (SPACHI), in the second case, it can be concluded that there is a significant correlation between the business and sporting achievements and the generically significant number of officially

held sporting manifestations segment. Theoretically, it is possible to explain the strategic performances on the so-called EVA conception (Economic Value Added) (Hill W. L. C., Jones R. G., 1998), which is consisted of four fundamental pillars of competitive advantage, and which are as follows: (1) (superior) *efficacy*, (2) (superior) *quality*, (3) (superior) *innovation*, (4) (superior) *reactivity to customers*. Outcomes of the conducted correlation analyses make it possible to rationalise the selection of the first, the second, and the third generically fundamental blocks of the competitive advantage in the number of officially held sporting manifestations segment, based on the *efficacy*, the *quality* and the *reactivity to customers* of the sporting products/services in football.

Statistical significance of the correlations between the number of officially held sporting manifestations variables, from senior category to cadet category, and the sporting achievement variable (SPACHI), verify the presence of significant sporting achievements of the football sporting organisations, which provide the attractiveness, the publicity, the marketing and the entrepreneurial potentials of the primary sporting product. The outcomes of the correlation analyses of the average attendance by a single official competition on the home field variable (ATTENDAN) and the sporting achievement (SPACHI) lead to additional conclusions of this sort.

*b) Correlation between the officially held sporting manifestations segment and the business and sporting achievements segment in basketball*

Definition of Spearman's non-parametric correlation coefficients shows the analysis of the correlation between the structure and number of the officially held sporting manifestations segment with the business and sporting achievement variables in basketball for the 2003/04 season, in Table 2. Based on the presented outcomes, this research verified the statistically significant correlation between the business achievement variable (BUSACHI) with the following variables: number of officially held sporting manifestations in the senior competition – men (OFFICMAN); number of officially held sporting manifestations in the competition of juniors-men (OFFICMANJM); number of officially held sporting manifestations in the competition of juniors-

women (OFFICMANJW); number of officially held sporting manifestations in the competition of cadets - women (OFFICMANCW); total number of officially held sporting manifestations in the category of seniors (TOTOFFMAN); and the average attendance by a single official competition on the home field variable (ATTENDAN).

**Table 2.** Correlation between the business and sporting achievements variable and the primary sporting product variable in basketball for the 2003/04 season.

| Basketball | BUS  |      |    | SPA  |      |    |
|------------|------|------|----|------|------|----|
| Spearman   | R    | P    | N  | R    | P    | N  |
| OFFICMAN   | 0.52 | 0.03 | 18 | 0.59 | 0.01 | 18 |
| OFFICMANSW | 0.15 | 0.55 | 18 | 0.26 | 0.29 | 18 |
| OFFICMANJM | 0.54 | 0.02 | 18 | 0.47 | 0.05 | 18 |
| OFFICMANJW | 0.50 | 0.04 | 18 | 0.39 | 0.11 | 18 |
| OFFICMANCM | 0.46 | 0.05 | 18 | 0.37 | 0.13 | 18 |
| OFFICMANCW | 0.49 | 0.04 | 18 | 0.47 | 0.05 | 18 |
| TOTOFFMAN  | 0.60 | 0.01 | 18 | 0.81 | 0.00 | 18 |
| ATTENDAN   | 0.77 | 0.00 | 18 | 0.62 | 0.01 | 18 |
| BUSACHI    | 1.00 | 0.00 | 18 | 0.67 | 0.00 | 18 |
| SPACHI     | 0.67 | 0.00 | 18 | 1.00 | 0.00 | 18 |

Sporting achievement variable (SPACHI) shows a statistically significant correlation with the following variables: number of officially held sporting manifestations in the senior competition – men (OFFICMAN); number of officially held sporting manifestations in the competition of cadets-women (OFFICMANCW); total number of officially held sporting manifestations in the category of seniors – men and women (TOTOFFMAN); and the average attendance by a single official competition on the home field variable (ATTENDAN).

The analyses conducted in this research also verified the statistically significant correlation between the business achievement variable (BUSACHI) and the sporting achievement variable (SPACHI). Based on the outcomes of the statistically significant correlation coefficients of the structure and number of officially held sporting manifestations variables in basketball, and which are as follows: number of officially held sporting manifestations in the senior competition – men (OFFICMAN); number of officially held sporting manifestations in the competition of juniors-men (OFFICMANJM); number of officially held sporting manifestations in the competition of juniors - women (OFFICMANJW); number of officially held sporting manifestations in the competition of cadets-women (OFFICMANCW); total

number of officially held sporting manifestations in the category of seniors – men and women (TOTOFFMAN); and the average attendance by a single official competition on the home field variable (ATTENDAN) and the business achievement variable (BUSACHI), in the first case, and the outcomes of the statistically significant correlation coefficients of the structure and number of officially held sporting manifestations variables, such as: number of officially held sporting manifestations in the senior competition – men (OFFICMAN); number of officially held sporting manifestations in the competition of cadets-women (OFFICMANCW); total number of officially held sporting manifestations in the category of seniors – men and women (TOTOFFMAN); and the average attendance by a single official competition on the home field variable (ATTENDAN), and the sporting achievement variable (SPACHI), in the second case, it is possible to rationalise the selection of the first, the second, and the fourth generically fundamental blocks of the competitive advantage of basketball clubs, based on the *efficacy*, the *quality* and the *reactivity to customers*.

Such selection of the synergic and the strategic operations of basketball clubs at the market, analysed based on the outcomes of the correlation coefficients of the number of officially held sporting manifestations segment, business and sporting achievement in basketball variables, objectifies the very quality of governance strategy. Statistical significance of coefficient correlations between the average attendance by a single official competition on the home field variable (ATTENDAN) and the sporting achievement variable (SPACHI), in addition to the other aforementioned statistically significant outcomes of correlation analyses, objectifies the successful management within basketball clubs, which clearly show potentials for their economic development.

Statistical significance of coefficient correlations between the number of officially held sporting manifestations variables in basketball clubs from senior category to cadet category competitions for men and women and the sporting achievement variable (SPACHI) indicates the presence of significant sporting achievements, which verify the attractiveness, the marketing and the entrepreneurial potentials of the primary sporting product in basketball.

c) *Correlation between the officially held sporting manifestations segment and the business and sporting achievements in volleyball*

Definition of Spearman's non-parametric correlation coefficients shows the analysis of the correlation between the structure and number of the officially held sporting manifestations segment with the business and sporting achievement variables in volleyball for the 2003/04 season, in Table 3.

**Table 3.** Correlation between the business and sporting achievement variable and the primary sporting product variable in volleyball for the 2003/04 season.

| Volleyball   | BUS   |      |    | SPA   |      |    |
|--------------|-------|------|----|-------|------|----|
| Spearman rho | R     | P    | N  | R     | P    | N  |
| OFFICMAN     | 0.11  | 0.76 | 10 | 0.25  | 0.49 | 10 |
| OFFICMANSW   | -0.05 | 0.89 | 10 | 0.35  | 0.33 | 10 |
| OFFICMANJM   | 0.11  | 0.76 | 10 | 0.25  | 0.49 | 10 |
| OFFICMANJW   | -0.18 | 0.61 | 10 | 0.21  | 0.55 | 10 |
| OFFICMANCM   | 0.32  | 0.37 | 10 | -0.04 | 0.92 | 10 |
| OFFICMANCW   | -0.10 | 0.78 | 10 | -0.14 | 0.71 | 10 |
| TOTOFFMAN    | 0.09  | 0.80 | 10 | 0.39  | 0.26 | 10 |
| ATTENDAN     | 0.14  | 0.71 | 10 | 0.54  | 0.11 | 10 |
| BUSACHI      | 1.00  | 0.00 | 10 | 0.49  | 0.15 | 10 |
| SPACHI       | 0.49  | 0.15 | 10 | 1.00  | 0.00 | 10 |

Outcomes of the conducted statistical correlation analyses indicate the absence of the statistically significant correlations between the business achievement variable (BUSACHI) and the sporting achievement variable (SPACHI) and the structure and number of the officially held sporting manifestations variables in volleyball for the 2003/04 season, which leads to the conclusion that there are insufficient strategic process planning and activities within volleyball clubs in this generically significant segment.

d) *Correlation between the officially held sporting manifestations segment and the business and sporting achievements in team-handball*

Definition of Spearman's non-parametric correlation coefficients shows the analysis of the correlation between the structure and number of the officially held sporting manifestations segment and the business and sporting achievement variables in team-handball for the 2003/04 season, in Table 4.

**Table 4.** Correlation between the business and sporting achievement variable and the primary sporting product variable in team-handball for the 2003/04 season.

| SPORT        | BUS   |      |   | SPA  |      |   |
|--------------|-------|------|---|------|------|---|
| Spearman rho | R     | P    | N | R    | P    | N |
| OFFICMAN     | -0.14 | 0.77 | 7 | 0.27 | 0.56 | 7 |
| OFFICMANSW   | 0.34  | 0.46 | 7 | 0.23 | 0.63 | 7 |
| OFFICMANJM   | -0.67 | 0.15 | 6 | 0.60 | 0.21 | 7 |
| OFFICMANJW   | 0.24  | 0.61 | 7 | 0.16 | 0.73 | 7 |
| OFFICMANCM   | -0.67 | 0.10 | 7 | 0.61 | 0.15 | 7 |
| OFFICMANCW   | 0.62  | 0.14 | 7 | 0.41 | 0.36 | 7 |
| TOTOFFMAN    | 0.08  | 0.87 | 7 | 0.60 | 0.16 | 7 |
| ATTENDAN     | -0.15 | 0.75 | 7 | 0.30 | 0.51 | 7 |
| BUSACHI      | 1.00  | 0.00 | 7 | 0.02 | 0.97 | 7 |
| SPACHI       | 0.02  | 0.97 | 7 | 1.00 | 0.00 | 7 |

Based on the outcomes presented, this research defines that there are no statistically significant correlations between the business achievement variable (BUSACHI) and the sporting achievement variable (SPACHI) and the structure and number of the officially held sporting manifestations variables in team-handball for the 2003/04 season., which also leads to the conclusion that there are insufficient strategic process planning and activities within team-handball clubs in this generically significant segment.

### Discussion and conclusion

Outcomes of the conducted analyses indicate that there is a statistically significant correlation between the generically significant structure and number of officially held sporting manifestations segment and the business and sporting achievements in the sporting clubs in football for the competitive 2003/04 season. Furthermore, outcomes of the conducted analyses rationalise the justification and the quality of the selection of the first, the second, and the third generically fundamental blocks of the competitive advantage in the number of officially held sporting manifestations segment, which is based on the *efficacy*, the *quality* and the *reactivity to customers*. Outcomes of the correlation coefficients verify the presence of significant sporting achievements of the football sporting organisations by which it is possible to provide attractiveness, publicity, marketing and entrepreneurial potentials of the primary sporting product and, by that, a higher public attendance levels, especially in competitions that are held on the home field. In the case of basketball, as it was the case in football,

the outcomes of the conducted analyses indicate that there is a statistically significant correlation between the business and sporting achievement segment and the generically significant structure and number of officially held sporting manifestations segment. Outcomes of the statistically significant correlation coefficients of the structure and number of officially held sporting manifestations in basketball variables, rationalise the justification and the quality of the selection of the first, the second, and the fourth generically fundamental blocks of competitive advantage of basketball clubs, based on the *efficacy*, the *quality* and the *reactivity to customers*. Such selection of the synergic and the strategic operations of basketball clubs at the market in basketball objectifies the very quality of governance strategy. Outcomes of the correlation coefficients verify the presence of significant sporting achievements of basketball clubs, by which these sporting

organisations provide attractiveness, publicity, marketing and entrepreneurial potentials of the primary sporting product. In addition to the aforementioned, and based on the outcomes of the analyses, this research also verified the successful management within basketball clubs and, by that, better chances for their sustainable development at the market. Outcomes of the correlation analyses in team-sports of volleyball and team-handball do not verify the statistically significant correlation between the generically significant structure and number of officially held sporting manifestations segment and the business and sporting achievements, and we can conclude that there is an absence of synergic and strategic effects on the market volleyball clubs and team-handball clubs in terms of providing the maximum degree of the business and sporting achievements for the 2003/04 competitive season.

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## KORELACIJE GENERIČKOG SEGMENTA STRUKTURE I BROJA ZVANIČNO ODRŽANIH SPORTSKIH MANIFESTACIJA TIMSKIH SPORTOVA SA POSLOVNIM I SPORTSKIM USPJEHOM

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### Sažetak

Pitanje kvalitete istog (osnovnog) sportskog proizvoda i usluge, kao i njegove refleksije na uspješnost sportskih organizacija, ima presudan uticaj. U sportskoj djelatnosti, posebno kada je riječ o takmičarskom sportu, više nego u bilo kojoj drugoj industriji, kvalitet sportskog proizvoda, posebno osnovnog (isti sportski proizvod), vrlo je jasan i mjerljiv u vidu ostvarenog sportskog i poslovnog uspjeha. Svrha ovog istraživačkog rada je objektiviziranje potencijala i atraktivnosti osnovnog sportskog proizvoda timskih sportova nogometa, košarke, odbojke i rukometa Kantona Sarajevo u takmičarskoj sezoni 2003./04. na temelju provedenih korelacionih analiza generički značajnog segmenta strukture i broja zvanično održanih sportskih manifestacija sa poslovnim i sportskim uspjehom. Sagledavajući značaj osnovnog sportskog proizvoda unutar timskih sportova izraženog kroz generički segment strukture i broja zvanično održanih sportskih manifestacija i njegovu povezanost sa poslovnim i sportskim uspjehom moguće je kvantificirati uspješnost menadžmenta sportskih organizacija usmjerenih prema održivom razvoju u pogledu izbora generičkih strategija sa jasnim akcentom da samo „efikasnost“ sportskog uspjeha implicira „kvalitet“ poslovnog uspjeha.

**Ključne riječi:** korelacija, sportske manifestacije, poslovni i sportski uspjeh

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## WEIGHT-HEIGHT RELATIONS AS AN IMPORTANT FACTOR OF SUCCESS IN RACE WALKING

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### **Abstract**

*Race walking is a sports discipline requiring from the athlete, a race walker, a possession of certain anthropometric characteristics which apart from optimally administered training sessions exert some influence on the achievement of the top results in this sport. Serbia has a relatively small number of athletes who go in for and compete in race walking, a sport supposed to animate and appeal a great number of competitors because it is meant not only to have a competitive part but also a recreational one as well. The aim of this research is to present some weight – height relations of the race walkers who had achieved top results at the world championships. These results would prove useful for the coaches and sports experts in their selection of the children for race walking. The research encompassed 55 elite race walkers. The obtained results point to the fact that the average body height is 176, 51  $\pm$  5, 52 cm, and body mass is 64, 85  $\pm$  5, 02 kg. According to the average values of the body mass index (20, 80  $\pm$  1, 07 kg/m<sup>2</sup>) race walkers belong to the group of lower limit values of the normally nutrition persons. These athletes have on average smaller body mass for 5 kg compared to the ideal body mass calculated by the Lorenz formula.*

**Key words:** *race walking, weight, height, body mass*

### **Introduction**

Race walking is a sports discipline requiring from the athlete, a race walker, a possession of certain anthropometric characteristics which apart from optimally administered training sessions exert some influence on the achievement of the top results in this sport. This especially implies height and weight of the body. Namely, optimal body mass retention in athletes of all sports disciplines presents an important factor in achieving top sports results. Under optimal body mass one implies that mass that enables an athlete to achieve maximum top results. It is extremely important in race walking that optimal body mass correspond to certain body composition of the race walker. First of all one thinks of body height and circular dimension of the race walker's body. A great number of authors researched ideal body mass trying to determine ideal body mass of the particular walker on the basis of his body height. Only in athletics does each discipline require different body mass whereas body height remains the same. So in sprinters optimal body mass is different in relation to long distance runners, shot putters, high jumpers, marathon runners and the like, let alone other sports fields. Determination of the optimal body mass of each athlete has channeled the aim of this paper.

The main purpose of this research is to point out to the significance of the height- weight relations of the elite race walkers and to determine exactly the relations that are crucial for the estimation of the optimal body mass that would be one of the hosts of factors significant for the cusses in race walking.

### **Method**

Research is conducted on the sample of the elite 55 race walkers at 50 km of average age 27,69  $\pm$  4,68, and 30 elite race walkers at 20 km, of average age 27,02  $\pm$  3,90. On the basis of the body height and body mass an ideal body mass was calculated according to the Lorenz formula:  $ITM = (VT - 100) = (VT - 150 \times 0,25)$ , VT body height in cm, Body mass index was calculated according to the formula:  $BMI = MT/VT^2$ : MT – body mass in kg, VT body height in m, and Kettle's index according to the formula:  $TVI = MT/VT$ : MT – body mass in gr, VT body height in cm. Tables have shown following variables coded as: age (GSTAR), body height in cm (AVIST), body mass in kg (AMAST), ideal body mass according to Lorenz in kg (AITEM), body mass index in kg/m<sup>2</sup> (BMASI), Kettle's weight-height index in gr/cm (KETELI) and achieved time in 1999 in min. (TIME).

## Results

Tables show basic statistical parameters of the body mass and height, ideal body mass, Kettle's weight-height index of elite race walkers at 50 km.

Table 1. Basic statistical parameters of the body mass and height, ideal body mass, Kettle's weight-height index of elite race walkers at 50 km.

| VARIABLE | MEAN   | SD    | CV    | MIN    | MAX    |
|----------|--------|-------|-------|--------|--------|
| GSTAR    | 27,69  | 4,68  | 16,90 | 19,00  | 43,00  |
| AVIST    | 176,51 | 5,52  | 3,12  | 163,00 | 188,00 |
| AMAST    | 64,85  | 5,02  | 7,74  | 53,00  | 77,00  |
| AITEM    | 69,88  | 4,14  | 5,92  | 59,75  | 78,50  |
| BMASI    | 20,80  | 1,07  | 5,14  | 17,30  | 23,18  |
| KETLI    | 367,13 | 21,14 | 5,76  | 302,86 | 418,48 |
| TIME     | 235,56 | 9,90  | 4,20  | 219,54 | 267,50 |

Table 2. Basic statistical parameters of the height, body mass, ideal body mass, Body mass index, and Kettle's weight-height index of elite race walkers (at 20 km)

| VARIABLE | MEAN   | SD    | CV    | MIN    | MAX    |
|----------|--------|-------|-------|--------|--------|
| GSTAR    | 27,02  | 3,90  | 14,43 | 20,00  | 35,00  |
| AVIST    | 176,91 | 4,73  | 2,67  | 168,00 | 186,00 |
| AMAST    | 66,17  | 6,03  | 9,11  | 51,00  | 78,00  |
| AITEM    | 70,18  | 3,54  | 5,04  | 63,50  | 77,00  |
| BMASI    | 21,11  | 1,40  | 6,63  | 17,64  | 24,72  |
| KETLI    | 373,71 | 28,10 | 7,51  | 300,00 | 427,77 |
| TIME     | 130,57 | 2,26  | 1,73  | 125,20 | 134,59 |

Table 3 Statistical significance of differences in arithmetic means of the body height, body mass, ideal body mass, body mass index and Kettle's weight-height index of elite walkers at 20 and 50 km

| VARIABLE | HODAI 50 KM |       | HODAI 20 KM |       | P     | T      |
|----------|-------------|-------|-------------|-------|-------|--------|
|          | MEAN        | SD    | MEAN        | SD    |       |        |
| GSTAR    | 27,69       | 4,68  | 27,02       | 3,90  | 0,67  | > 0,05 |
| AVIST    | 176,51      | 5,52  | 176,91      | 4,73  | -0,37 | > 0,05 |
| AMAST    | 64,85       | 5,02  | 66,17       | 6,03  | -0,87 | > 0,05 |
| AITEM    | 69,88       | 4,14  | 70,18       | 3,54  | -0,34 | > 0,05 |
| BMASI    | 20,80       | 1,07  | 21,11       | 1,40  | -1,15 | > 0,05 |
| KETLI    | 367,13      | 21,14 | 373,71      | 28,10 | -1,22 | > 0,05 |

Table 4 Basic statistical parameters of the height, body mass, ideal body mass, Body mass index, and Kettle's weight-height index of 5 elite race walkers at 50 km and values of the most successful Serbian walker Rakovic.

| VARIABLE | 5 BEST WALKERS ON 50 KM |       |      |        |        | RAKOVIC |
|----------|-------------------------|-------|------|--------|--------|---------|
|          | MEAN                    | SD    | CV   | MIN    | MAX    |         |
| GSTAR    | 27,60                   | 2,19  | 7,93 | 24,00  | 30,00  | 32,00   |
| AVIST    | 173,60                  | 4,87  | 2,80 | 168,00 | 181,00 | 184,00  |
| AMAST    | 64,00                   | 3,53  | 5,51 | 60,00  | 69,00  | 74,50   |
| AITEM    | 67,70                   | 3,56  | 5,26 | 63,50  | 73,00  | 75,50   |
| BMASI    | 21,52                   | 0,80  | 3,72 | 20,58  | 22,60  | 22,04   |
| KETLI    | 368,48                  | 11,90 | 3,23 | 357,14 | 381,50 | 410,33  |

Analyzing results shown in Table 1 one can state that the average age of the race walkers at 50 km is 27, 69  $\pm$  4, 68 and that the range between the youngest and the oldest walker is 24 years. This age heterogeneity is also reflected in the variation coefficient. Namely, 16.90% of walkers differ in age from the average age. Average body height of the walkers is 176, 51  $\pm$  5, 52 cm and is within the limits of the non-athletes average body height. Difference between the biggest and the smallest body height values is 18 cm and apart from that variation coefficient points to the great homogeneity in this discipline. ( $C_v=3, 12\%$ ). Average walking time at 50 km is 235, 56  $\pm$  9, 90 min (3.42.41). Variation coefficient points to the fact that only 4, 20% of walkers differ in time of walking this track from the average result.

### **Discussion and conclusion**

By analyzing the results of the best 5 walkers in the world at 50 km one gets the following results: Average age is 27,6  $\pm$  2,19, body height is 173,60 $\pm$ -4,87 cm, body mass is 64,0 $\pm$ -3,53 kg and is less than 3,7 kg when compared to the ideal body mass calculated according to Lorenz formula (67,70 $\pm$ -3,56 kg). Body mass index is 21,52 $\pm$ -0,80 kg/m<sup>2</sup>, Kettle's weight-height index in gr/cm is 368,48 $\pm$ -11,90gr/cm, and walking time is 3,41.30 $\pm$ -0,13 hours. Results show that the first five walkers are on average of smaller body height values in relation to all walkers at 50 km but not statistically significant, they are of the same body mass, somewhat higher values of Body mass index and Kettle's weight-height index

(Table 5). Results shown in Table 2 point to the fact that average age of the walkers at 20 km is identical to the average age of the walkers at 50 km which is the same for the average body height. Body mass of the 20 km walkers is bigger. Analyzing results shown in Table 3 we can state that there is no statistical significance of differences in analyzed weight-height relations and well as in height and body mass of the 50 and 20 km race walkers. It is important to state that there is numerical difference in body height and body mass and weight-height relations with a remark that these values are bigger in 20 km walkers. Analyzing results of 5 elite race walkers at 50 km and values of the most successful Serbian walker Rakovic we can state that the values of Rakovic in all analyzed variables are by far above average and maximal values of the best race walkers. Body mass of the walkers is -4, 0 kg of the value of ideal body mass calculated according to Lorenz. If we accept this as true, body mass of our walker should read 70, 5 kg. Values of body mass index ranging from 19-24,9kg/m<sup>2</sup> encompass persons of normally nutrition state. According to average values walkers have these values which are closer to the lower limit of the normally nutrition persons. This is understandable because we talk here about athletes whose discipline calls upon smaller body mass. Values of the Kettle's weight-height index in walkers are closer to the values of this index in marathon runners (350gr/cm), in sprinters this index is 401 gr/cm), and in shot put throwers is 613 gr/cm.

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## RELACIJE VISINE I TEŽINE KAO ZNAČAJAN FAKTOR USPJEHA U BRZOM HODANJU

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### Sažetak

Brzo hodaње je sportska disciplina koja od sportaša zahtijeva posjedovanje određenih morfoloških značajki koje odstupaju od uobičajeno praćenih svojstava u trenažnim sesijama kako bi se osigurali uslovi za postizanje vrhunskog rezultata. Srbija ima relativno mali broj sportaša koji prate takmičenja u brzom hodaњу, tj. u sportu za koji se pretpostavlja da animira i privlači veći broj takmičara budući omogućava takmičenja ali isto tako i rekreativno bavljenje. Cilj ovog rada je da predstavi neke relacije visine i težine kod hodača koji su ostvarili vrhunski rezultat na svjetskom prvenstvu. Ovi rezultati mogu koristiti trenerima u sportu i sportskim stručnjacima u selekciji djece za hodaње. Bilo je uključeno 55 elitnih hodača. Dobiveni rezultati ukazuju na to da je prosječna visina 176.51 +/- 5.52 cm, a tjelesna masa 64.85 +/- 5.02 kg. U skladu sa prosječnom vrijednošću BMI (body mass index) od 20.80 +/- 1.07 kg/m<sup>2</sup>, hodači pripadaju skupini koja je na donjoj granici "normalnih" osoba. Ovi sportaši imaju prosječno manju masu od 5 kg u poređenju sa "idealnom" masom izračunatom po Lorenzovoj formuli.

**Ključne riječi:** brzo hodaње, visina, težina, masa tijela

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## COMPARISON OF DIFFERENT TAXONOMY PROCEDURES

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### **Abstract**

*The purpose of this study was the comparison of the different taxonomy procedures which are universally applicable to social studies. The design of the study was pointed towards the identification of the characteristics of the individual taxonomy procedures with the algorithmic coding in Borland Delphi developing tool (D.Bonacin). The data of 249 students described with 14 morphological variables was processed for the purpose of this study. The results have shown the divergences in different taxonomy procedures. It was possible to identify the logic of these procedures, and to suggest the application of different models in particular scientific situations. Methodological constraints of the study are possible to find only if a more complex algorithm which entails all of the characteristics of the analyzed procedures is generated. The originality of the study lies in the completely new approach to the object classification, complete with the proposition which procedure to apply in different situations.*

**Key words:** *classification, taxons, polar, distinct*

### **Introduction**

In every scientific discipline there is a classification of the objects which are studied. The term classification basically corresponds to the formation of groups which are not known to the arbitrarily defined total sample, described with an arbitrary number of quantity variables. In that way the groups which are by some criteria scientifically sustainable are extracted from the total mass. As we can see, the idea here is the identification of the unknown phenomena. Different forms of classification are long known, but their character was mostly arbitrary, because the final result was much dependant on the settings of the scientist involved, and that made the final outcome very disputable. The situation deteriorated with the introduction of the even greater number of variables with which the objects are described.

However, with the development of the computers, there followed a great number of algorithms and programs for the object classification. Although these procedures cannot are not without merit in some situations, we must point out that the problem of classification (taxonomisation) is not solved up to date. In scientific practice there is still a doubt connected to the taxonomisation, a doubt which stems from serious contemplations affiliated with distribution of the human traits.

According to some, these traits are usually normally distributed which means that it is not realistic to expect the real existence of real taxons (types) inside the samples represented, and in this case the taxons are only artifacts. On the other hand, many research shows that in large number of human dimensions (morphological, cognitive... etc) there is initially no multivariable normal distribution, but a distinct and multi-modal distribution, so the existence of the real taxons is not a mere mathematical artifact.

For these reasons exactly, we need to approach these taxonomy procedures with a lot of attention and with respect for the real knowledge of the analyzed phenomena.

### **Basic taxonomy models**

For the purpose of this work the examples from three areas will be analyzed: a) Distinct taxons (the taxons which allow the allocation of one object on one, and only one taxon), b) Polar taxons (the taxons which take to extremes one latent taxonomic dimension on the opposite side of latency, and which allow non-trivial allocation of one object on more than one object), and c) The alternative model which entails good traits of both of the above mentioned models.

### *The distinct model - Hierarchical grouping*

This procedure basically tries to group the object in order to enable the hierarchical allocation into the smallest group based on the successive adjoining (Veldman, 1967). The two big flaws of this procedure are that there are no levels, but multidimensional adjoining on the basis on similarity, and the objective number of really existent taxons.

### *The Distinct Model - The Uditax extremes*

This procedure (Bonacin, 2004) proved itself as one of the best procedures in over a 100 real situations, even when the groups of objects were vaguely defined. The procedure initially defines extreme objects (initial micro-taxons) and later one by one taxon is added, creating the real taxonomic groups. Analytically, this is probably the best taxonomic procedure.

### *The alternative model - integrating taxons*

This procedure (Bonacin, 2002) is the upgraded model of the hierarchical grouping and it produces additional information and objectifies the number and the structure of the taxons derived by some other method. The results allow fairly objective conclusions and interpretations.

### *Poltax model of the polar taxons*

This procedure (ex. Momirović et al, 1987) is a generalization of the Catell logic by which the taxonomic dimensions do not have their own projections in relation to centroids of the groups, but in relation to extreme groups of objects, and so one taxonomic dimension has a dual role and one common trait. This logic was proven as equally valid and equally bad, which led to the series of doubts in terms of adequacy.

### **The example of the results**

For the comparison of the results' quality of taxonomic analysis, 249 male entities aged 7 (+/- 2 months) have been analyzed using 14 quantitative variables designed to completely cover morphological area, latently dimensioned as: a) longitudinally (height, arms' length, legs' length), b) transversal (knee diameter, wrist diameter, biacromial range, bicristal range), c) body mass and volume (weight, forearm diameter, calf diameter, chest diameter, d) fat tissue

(skinfold on forearm, skinfold on the back, skin fold of the belly). All the variables are standardized to level the influence of individual variables. This example is chosen because it is rather straightforward, although much more complex cases have been compared.

### *The Distinct Model - Hierarchical Grouping*

| G    | GR01  | GR02  |
|------|-------|-------|
| N    | 194   | 55    |
| %    | 77.91 | 22.09 |
| AVIT | -0.22 | 0.77  |
| ADUN | -0.20 | 0.72  |
| ADUR | -0.21 | 0.76  |
| ADRZ | -0.20 | 0.69  |
| ADIK | -0.22 | 0.79  |
| ASIR | -0.22 | 0.76  |
| ASIK | -0.23 | 0.82  |
| ATEZ | -0.40 | 1.41  |
| AOPL | -0.31 | 1.09  |
| AOPK | -0.34 | 1.21  |
| AOGK | -0.35 | 1.22  |
| AKNN | -0.36 | 1.28  |
| AKNL | -0.33 | 1.17  |
| AKNT | -0.39 | 1.37  |

The model of hierarchical grouping has shown as a result two groups which are produced in accordance to the criteria of growth of the total grouping error.

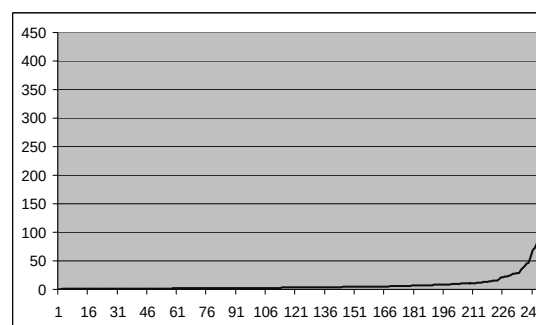


Figure 1. Group error in simultaneous phases

In the first group there are 194, and in the second 55 objects. The analysis of the dendrogram has shown that the grouping was not convincing enough, and neither the number nor the character of the given taxons is certain. The average values of the taxons on the variables show that the first taxon defines completely average entities, but with the values slightly under the average. In other words, the objects with medium or small body mass, small volume, low longitudinal, and with little body fat. The second one, on the opposite, defines the objects with much bigger body mass, especially fat tissue and volume.

*The Alternative Model - Integrating Taxons*

|      | PRX1  | PRX2  |
|------|-------|-------|
| AVIT | 0.41  | -0.03 |
| ADUN | 0.35  | 0.01  |
| ADUR | 0.37  | 0.01  |
| ADRZ | 0.26  | 0.08  |
| ADIK | 0.32  | 0.07  |
| ASIR | 0.46  | -0.08 |
| ASIK | 0.27  | 0.13  |
| ATEZ | 0.21  | -0.44 |
| AOPL | 0.24  | -0.28 |
| AOPK | 0.22  | -0.34 |
| AOGK | 0.20  | -0.36 |
| AKNN | -0.05 | -0.62 |
| AKNL | -0.10 | -0.61 |
| AKNT | -0.10 | -0.70 |
|      | PRX1  | PRX2  |
| PRX1 | 1     | 0.33  |
| PRX2 |       | 1     |

The model of the integrating taxons, out of which the data is brought to diagonally rotating Promax taxons on the variables, has shown that two isolated taxons are much clearer than in the previous example. Namely, the first one describes the objects with the defined skeleton dimensions, while the second one obviously is growth and soft tissue development mechanism (musculature and soft tissue).

It is still 194+55 objects, but their definition is much more precise in the space of variables. It is also visible that these two taxons are not orthogonal, but have very positive relations ( $r=0,33$ ), the number derived from the dimensions of volume, as to say clearly non-differentiated morphological dimensions at this age. As we see, the alternative model of the taxon has shown a more precise definition than the hierarchical grouping.

*The Distinct Model-Uditax positions on the basis of the extreme objects*

The results of the Uditax taxonomic procedure have shown the existence of the two well defined taxons, where the first certainly entails mass, volume and skeleton measurements. All of the morphological indicators are equal in the range of average value from 0.50 to 0.80.

The other taxon is constituted in the identical way, but with the negative value, with which it forms the general typology of children very similar to hierarchical grouping, but with more prominent values.

It is noticeable, however, that the number of objects is significantly different, there is now 114, or 135 objects per taxon.

|                  | DT01  | DT02  |
|------------------|-------|-------|
| N                | 114   | 135   |
| %                | 45.78 | 54.22 |
| AVIT             | 0.64  | -0.54 |
| ADUN             | 0.56  | -0.48 |
| ADUR             | 0.57  | -0.48 |
| ADRZ             | 0.64  | -0.54 |
| ADIK             | 0.64  | -0.54 |
| ASIR             | 0.55  | -0.47 |
| ASIK             | 0.54  | -0.46 |
| ATEZ             | 0.82  | -0.69 |
| AOPL             | 0.68  | -0.57 |
| AOPK             | 0.73  | -0.62 |
| AOGK             | 0.73  | -0.62 |
| AKNN             | 0.55  | -0.47 |
| AKNL             | 0.47  | -0.39 |
| AKNT             | 0.58  | -0.49 |
| Positions of the |       |       |
|                  | DT01  | DT02  |
| GR01             | 2.35  | -1.99 |
| GR02             | -2.35 | 1.99  |

This describes the real situation much more accurately (on the basis of the insight on the initial data). It is noticeable that the Uditax procedure has integrated the object with large fat tissue and those with big volume, which is justified considering the fact that the morphological differentiation has not yet occurred at this age. The relation of these two taxons is diametrically opposite, which is logical, because we highlight two divergent developmental attributes.

*The Polar Model- Polar Taxons Model*

|                            | TX1   | TX2   |
|----------------------------|-------|-------|
| AVIT                       | -0.11 | 0.97  |
| ADUN                       | -0.11 | 0.90  |
| ADUR                       | -0.12 | 0.91  |
| ADRZ                       | 0.14  | 0.62  |
| ADIK                       | 0.23  | 0.58  |
| ASIR                       | 0.16  | 0.62  |
| ASIK                       | 0.34  | 0.40  |
| ATEZ                       | 0.65  | 0.43  |
| AOPL                       | 0.67  | 0.19  |
| AOPK                       | 0.65  | 0.28  |
| AOGK                       | 0.74  | 0.18  |
| AKNN                       | 0.97  | -0.22 |
| AKNL                       | 1.05  | -0.39 |
| AKNT                       | 1.01  | -0.25 |
| Correlations of the taxons |       |       |
|                            | 1     | 0.55  |
|                            |       | 1     |
| % of the objects           |       |       |
|                            | 53.71 | 46.29 |

## Discussion and Conclusion

The results of the polar taxons' analysis have shown that it is possible to push to extreme the data in the way that the first taxon represents the development of the soft tissue (fat tissue dominant), while the other represents skeleton growth (longitudinality dominant). The other dimensions (volume, mass) are present to a certain degree in both taxons, meaning that they do not fully contribute to their real typological definition. The two mentioned mechanisms of morphological growth and development are in medium and significant correlations ( $r=0.55$ ), and those relations are predominant in this analysis. The percentage of the entity allocation should be regarded with a reserve, but the number of the objects is relatively balanced (53% and 46%, 134 and 115 objects). Taxonomic procedures have shown that, although the final results are fairly similar, there are significant deviations, so the question which procedure to trust is justified. It is obvious that it cannot be clustering by hierarchical grouping, and even though the alternative model has brought some improvement, the number of objects per taxon is still not balanced, which after a detailed check of the initial data is not acceptable. The Polar taxons and the Uditax have brought similar results considering the number of objects, but there are differences in accordance with the basic principles of the two procedures.

Namely, while Uditax is a provider for the explication of distinct taxons, Poltax is a polar model. It seems justified to assume that the extremization is justified because it tends to extract real groups in a pattern, and both procedures are based on extremization. It is noticeable that the integrating taxons 'act' similarly to polar taxons, and Uditax similarly to hierarchical grouping. We can conclude that there is two-dimensional matrix which helps to decide what procedure gives objective results. In one dimension there is a number of objects, and in other distinct/non-distinct orientation.

Table 1. The logic of the two-dimensional matrix for deciding

|          | Non-balanced        | Balanced |
|----------|---------------------|----------|
| Distinct | Hierarchical group. | Uditax   |
| Polar    | Integrating         | Poltax   |

It is safe to recommend all four procedures in the following cases: a) Hierarchical grouping with distinct taxons with non-balanced number of objects per taxon, b) Integrating taxonomy model with polar taxons with non-balanced number of objects per taxon, c) Uditax taxonomy model with distinct taxons with balanced number of objects per taxon, and d) Poltax taxonomy model with polar taxons with balanced number of objects per taxon. It is generally possible to recommend Uditax and Poltax models.

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## POREĐENJE RAZLIČITIH TAKSONOMSKIH PROCEDURA

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### Sažetak

Svrha ovog istraživanja bila je poređenje različitih taksonomskih procedura koje je moguće standardno koristiti u društvenim naukama. Dizajn istraživanja bio je usmjeren prema identifikaciji karakteristika pojedinih taksonomskih procedura uz kodiranje algoritama u Borland Delphi razvojnom alatu (D.Bonacin). Za potrebe ovog istraživanja i primjer obrađeni su podaci 249 učenika opisanih sa 14 morfoloških varijabli. Rezultati su pokazali da postoje divergencije u dobivenim rezultatima različitih taksonomskih postupaka. Bilo je moguće identifikovati logiku tih postupaka i kao praktične implikacije predložiti primjenu pojedinih modela u karakterističnim naučnim situacijama. Metodološka ograničenja istraživanja moguće je pronaći samo ukoliko se generira neki složeniji algoritam koji bi objedinio sva navedena svojstva analiziranih postupaka. Originalnost rada ogleda se u posve novom cjelovitom pristupu klasifikaciji objekata s prijedlogom primjene postupaka u karakterističnim situacijama.

**Ključne riječi:** klasifikacija, taksoni, polarni, distinktni

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## THE STRUCTURAL CHANGES IN SPORT GAMES DURING PHYSICAL AND HEALTH EDUCATION CLASSES

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Original scientific paper

### Abstract

*On the sample of 152 examinees (male students) of Catholic School Center (High School) in Sarajevo, a program has been conducted in duration of one school year, from basketball, volleyball, handball and football classes. For estimation of basic motor abilities 24 tests were applied and 12 tests were applied for situational motor abilities (3 per each sport game). Initial and final measurements were also made (in September and May). The goal of this research was to ascertain the structural changes in basic mobility and situational mobility after the scheduled action, namely, to ascertain the transformational process. For the analysis of qualitative changes the Lsdif, Qdiff1 and Cramer analyses were used. The results of this research show that a general, systematic and continual reconstruction of general and specific motor abilities has occurred, namely the transformation of the same, but not in a significant measure. The smallest effects have been achieved in the case of football.*

**Key words:** structural changes, transformation, sport games, basic, situational motor abilities

### Introduction

In many former researches, it has been ascertained that the usage of specific exercise processes can significantly effect the changes of different human features, abilities and motor proficiencies. In this sphere of education's interests, there are numbers of scientific questions. Some of the basic scientific questions in this aspect of education problems are what to train, how to train and how much in order for changes to occur, how to control the quantitative and qualitative variability.

The changes of motor abilities in education process represent a dynamic, billowy process which is specific for its adequate quantitative and qualitative indicators. It is clear that this is the case of transformational process which occurs during classes, namely through his "most often occurring" units. It is not necessary to waste words on didactical and methodical protocols such as: planning, programming, feedback info, the intensity and size of the project, etc, which should by all means be valued in case of any longitudinal study. The works of recent "dates" treat the motor area not only in quantitative but also in qualitative sense. The structural changes represent the difference in motor abilities ratio trough

specific transformational process and within a time distance of course. The qualitative changes indicate basic progress in the motor achievement segment and they represent a kind of "basis" on which the quantitative, linear, global, fractal and other transformational effect indicators are achieved. It is necessary to mention that sport games all have their separate characteristics, goals and exercises, thus their own rules of "development" (in the motor sense). The goal of this research was to register the qualitative changes in basic and situational mobility (basketball, volleyball, football and handball) during the classes of Physical Education in duration of a school year (in initial and final measurement).

### Methods

The research has been conducted on the sample of 152 examinees (males), students of II and III grade, attending Basic Gymnasium in Sarajevo. The program consisted of standard class units in sport games including dribbling, ball passage, kicking, except volleyball which had ball lifting, smash and serving. The program was realized during one school year at which time initial and final measurement took place.

Frequency of classes was two times a week, and each class unit from sport games was realized during 12 classes. The bank of tests for the estimation of basic motor abilities were constituted as followed: fractal speed (hand tapping MTAP, foot tapping MTAN, foot tapping against the wall MTAZ), precision (darts MPIK, striking the horizontal goal with a ball MPLO, striking the goal with a foot MPNG) balance (standing on one foot with closed eyes MRIZ, standing on reverse bench MROK, standing on one foot along the balance bench MRIU), flexibility (touch-toe to the right MFDE, deep touch-toe on the bench MFDP, splits MFSP), coordination (coordination with a stick MKPA, slalom with three medical MKSL, 20 lunges with a stick MK20), sprint speed (50 meter running with high start MB50, 20 meter running with high start MB20, 4x15 meter running MB15), explosive strength (standing long jump MESM, ball throwing MEBL, vertical jump MEVS, repetitive strength (body alignment MRIT, body ascension in 30 seconds MR30, push-ups MRSK).

Situational motor abilities were estimated by tests: basketball (throwing the ball with both hands against a wall, capturing it in 30 seconds KOB, dribbling in slalom KOVO, shooting at the basket in duration of 30 seconds ODOD), volleyball (shooting at the goal across the net from the basic position ODGA, "bat sledge" rejection inside a circle in duration of 30 seconds, tennis serving and scholastic serving ODSE), handball (throwing and capturing of the ball against a wall in duration of 30 s RUBA, dribbling in slalom RUVO penalty throw RUSE), football (ball juggling NGZO, ball dribbling in slalom NGVO, strength of the ball hit NGSU). For the analysis of obtained data the Lsdif, Qdiff1 and Cramer analyses were used in order to register structural changes and situational motor abilities.

## Results

### *The structural changes in basic motor ability*

Table 1. The results of Lsdif analysis of structural changes in basic motor ability

| LSDIF              |          |
|--------------------|----------|
| TRACE OF MATRIX    | = 5.24   |
| HI-QUADRAT         | = 398.36 |
| DEGREES OF FREEDOM | = 24     |
| PROBABILITY        | = 0.0000 |

According to the results in table 1. After the final measurement, an obvious structural changes have occurred, which are more than significant as the quadrant of differences matrix explains, and the probability of a mistake in such a claim is 0.0000.

Table 2. The results of Qdiff1 analysis in basic motor ability

| QDIFF1 | Differences |
|--------|-------------|
| MTAP   | 0.20        |
| MTAZ   | 0.13        |
| MTAN   | 0.36        |
| MPIK   | 0.34        |
| MPLO   | 0.28        |
| MPNG   | 0.38        |
| MR1Z   | 0.47        |
| MROK   | 0.14        |
| MR1U   | 0.33        |
| MFDE   | 0.26        |
| MFDP   | 0.16        |
| MFSP   | 0.27        |
| MKPA   | 0.38        |
| MKSL   | 0.29        |
| MK20   | 0.28        |
| MB50   | 0.32        |
| MB20   | 0.25        |
| MB15   | 0.37        |
| MESM   | 0.22        |
| MEBL   | 0.41        |
| MEVS   | 0.21        |
| MRIT   | 0.19        |
| MR30   | 0.15        |
| MRSK   | 0.18        |
| G =    | 0.1665      |

The detailed information of the forms of structural changes can be seen in table 2, which contains the indicators of Qdiff1 analysis of structural changes. It is obvious that significant and unified changes have occurred along the entire spectrum of basic motor dimensions. The highest multi-variant structural changes occurred with balance and flexibility, but also in almost the same amount with all the other used variables. Weaker changes were gained only with a few variables, and even so they are not zero.

Additional information, which can corroborate claims that the structural changes exist, are visible in table 3. It can be seen that the changes are still medium in size, but also that they are present along the entire set of variables, as well that they all are over 0.10, which testifies of deep and radical changes in the structure of motor dimensions ratio, which have occurred after the treatment period. Weaker changes are shown with only a few variables, and even so they are not zero.

Table 3. The results of Cramer analysis of structural changes in basic motor ability (VKK-the coefficient of vector correlation, RO-the measurement of similarities, ALRO-the measurement of differences)

| CRAMER | Similarities | Differences |
|--------|--------------|-------------|
| MTAP   | 0.55         | 0.26        |
| MTAZ   | 0.60         | 0.23        |
| MTAN   | 0.61         | 0.22        |
| MPIK   | 0.47         | 0.32        |
| MPLO   | 0.50         | 0.29        |
| MPNG   | 0.38         | 0.39        |
| MR1Z   | 0.58         | 0.24        |
| MROK   | 0.37         | 0.39        |
| MR1U   | 0.58         | 0.24        |
| MFDE   | 0.66         | 0.19        |
| MFDP   | 0.74         | 0.14        |
| MFSP   | 0.63         | 0.21        |
| MKPA   | 0.34         | 0.42        |
| MKSL   | 0.50         | 0.29        |
| MK20   | 0.53         | 0.27        |
| MB50   | 0.69         | 0.17        |
| MB20   | 0.56         | 0.25        |
| MB15   | 0.66         | 0.19        |
| MESM   | 0.63         | 0.20        |
| MEBL   | 0.79         | 0.11        |
| MEVS   | 0.66         | 0.19        |
| MRIT   | 0.44         | 0.33        |
| MR30   | 0.55         | 0.26        |
| MRSK   | 0.34         | 0.42        |
| VKK =  | 0.0000       |             |
| RO =   | 0.0000       |             |
| ALRO = | 1.0000       |             |

It seems that under the influence of transformational process, a general systematic reconstruction of basic motor abilities has occurred, which is in many ways an interesting effect from the kineziological point of view, because it testifies that treated protocol can cause serious structural changes on the chosen sample of treated age.

Namely, that it is possible to cause an adequate reconstruction of motor abilities, with the help of sport games stimuli usage (basketball, volleyball, handball, football). The fact is that the examinees needed to adapt in great measure to the new requests and to learn new motions, which placed serious exercises in front of their motor functions.

But it is also a fact that under such a process an adaptation of motor functions was achieved, which were surely headed in the course of integrating dimensions responsible for the realization of motions, which is undoubtedly a positive kineziological influence.

### Structural changes in specific motor ability

Table 4. The results of Lsdif analysis of structural changes in specific motor ability

| LSDIF              |   |        |
|--------------------|---|--------|
| TRACE OF MATRIX    | = | 0.85   |
| HI-QUADRAT         | = | 64.40  |
| DEGREES OF FREEDOM | = | 12     |
| PROBABILITY        | = | 0.0000 |

According to the results in table 4, it is obvious that structural changes have occurred in the set of specific motions, changes which are more than significant. Lsdif probability of a mistake in such a claim is 0.0000, but it is also noticeable that the degree of change is lower by comparison with the motor functions. This can be explained with the fact that the examinees were constantly embedded with new parameters in motion engrams, which means that the period for this kind of treatment is relatively short, and it should certainly be considerably prolonged in sport.

Table 5. The results of Qdiff1 analysis of structural changes in specific motor ability

| QDIFF1 | Differences |
|--------|-------------|
| KOBA   | 0.23        |
| KOVO   | 0.11        |
| KOST   | 0.19        |
| ODGA   | 0.28        |
| ODOD   | 0.20        |
| ODSE   | 0.27        |
| RUBA   | 0.38        |
| RUVO   | 0.14        |
| RUSE   | 0.34        |
| NGZO   | 0.12        |
| NGVO   | 0.12        |
| NGSU   | 0.19        |
| G =    | 0.1266      |

According to the indicators in tables 5 and 6, which are completely coherent by all variables, it is clear that numerous and quite clear structural effects were caused. It can be seen that these effects were the lowest in the case of football, which can be explained with the fact that the examinees have already had experiences with football, so the transfer of these new football motions during this treatment would surely be less expressed.

It is similar with ball dribbling in basketball and handball. All other specific motions however, have gone through solid changes, which is especially true for handball actions.

But also the entire volleyball set of variables, most probably because the examinees have had much less experience with these motions in the true sense of the word and in the correct kinesiological way.

Table 6. The results of Cramer analysis of structural changes in specific motor ability

| CRAMER | Similarities | Differences |
|--------|--------------|-------------|
| KOBA   | 0.58         | 0.24        |
| KOVO   | 0.79         | 0.11        |
| KOST   | 0.56         | 0.25        |
| ODGA   | 0.56         | 0.25        |
| ODOD   | 0.65         | 0.19        |
| ODSE   | 0.49         | 0.30        |
| RUBA   | 0.38         | 0.38        |
| RUVO   | 0.75         | 0.14        |
| RUSE   | 0.38         | 0.38        |
| NGZO   | 0.77         | 0.12        |
| NGVO   | 0.81         | 0.10        |
| NGSU   | 0.55         | 0.26        |
| VKK =  | 0.0001       |             |
| RO =   | 0.0000       |             |
| ALRO = | 1.0000       |             |

## Conclusion

It can be generally concluded that both with basic and specific motor variables structural changes were caused, and also that these changes are more than significant. This testifies to the fact that by applying the stimuli from chosen sport games it is, of course, possible to change the structure of motor functions from which specific motor output directly depends. This is by itself clear, because in the process of learning any new motions, these effects will show it the treatment is seriously prepared and conducted. However, what is maybe much more important, is the fact that using these same stimuli the examinees' motor functions have changed and surely began to function on a higher level, which can be described as integration of these functions.

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Such changes in structure are in this case welcomed and the purpose of education (along with all educational, functional and the other kinds of exercises) is largely achieved.

These changes should be „provoked“ anyway, so that before an adequate boost of motor and other abilities on a higher quantitative level occurs, a good and desirable relations between motor dimensions and functions in general are founded. Only in such a way can we say that a successful transformational process has taken place, because the quantitative changes would almost always (and in education truly always) need to be preceded by the structural ones, so that an adequate „net“ of relations could be set up, on which it could be possible to further increase other functions such as explosive strength, flexibility, etc. In such a context, it would be difficult for different dimensions to clash, namely the synergy and coordination of these dimensions would be facilitated, since they strive to a common goal-an optimal management over complete and complex motions of any type.

Moreover, rare are the situations in which the interest for structural changes is small and in which the quantitative changes would be focus of interest. Maybe, (with a big question mark) in a situation of top-quality athletes, which have achieved an optimal structure of their dimensions in some part of their preparation, so further progress in the quantitative sense is enabled (eg. certain athletic disciplines during the year).

In all other cases, structural changes are and will remain the basis for understanding any kinds of treatment effects, even the quantitative ones.

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## STRUKTURALNE PROMJENE U SPORTSKIM IGRAMA U NASTAVI TJELESNE I ZDRAVSTVENE KULTURE

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### Sažetak

Na uzorku od 152 ispitanika muškog spola, koji pohađaju nastavu u Katoličkom Školskom Centru u Sarajevu, proveden je program u trajanju od jedne školske godine, s nastavom iz košarke, odbojke, rukometa i nogometa. Za procjenu bazičnih motoričkih sposobnosti primjenjena su 24 testa kao i 12 situacijskih motoričkih varijabli (po 3 za svaku sportsku igru). Inicijalno i finalno mjerenje su izvršeni u septembru i maju). Cilj ovog istraživanja bio je utvrđivanje strukturalnih promjena u bazičnoj i situacionoj motorici nakon provedenog programa, u suštini, valorizacija transformacijskog procesa. Za utvrđivanje strukturalnih promjena primjenjene su procedure Lsdif, Qdiff1 i Cramer. Rezultati ovog istraživanja pokazali su opću, sistematsku i kontinualnu rekonstrukciju općih i specifičnih motoričkih sposobnosti, za što je odgovoran transformacijski proces, iako ne u svim situacijama u jednakoj mjeri. Najslabiji efekti su zabilježeni u slučaju nogometa.

**Key words:** strukturalne promjene, transformacije, igre, bazična i situacijska motorika

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## ESTABLISHMENT OF THE FOOT ARCH INITIAL STATUS IN PRE-SCHOOL CHILDREN

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*Original scientific paper*

### **Abstract**

*One of the primary factors or reasons for the unsatisfactory postural status in pre-school children is their deformed feet. The great prevalence of foot deformity in pre-school and school children is a fact their parents and teachers have to face with on a daily basis. During their leisure time the majority of children reduce their physical activities to playing computer games and using PC. The postural status of the children population of this age is exposed to great risks. This study has established the deformity of the foot arch in pre-school 4- to 6-year-old boys and girls by the computerised and digitalised podography (CDP) method. The aim of this study was to reconstruct and establish the functioning of the initial postural status, that is foot status in pre-school children and to present the obtained results before the relevant institutions in order to provide much needed preventive treatment. Based on the obtained study results the following conclusion may be drawn: as much as 93% of the examined children had deformed feet, while only 7% had normal feet, without any deformity.*

**Key words:** *initial status, deformity, foot, children*

### **Introduction**

Based on the statistical data provided by the World Health Organisation, it has been concluded that the postural status of pre-school children is unsatisfactory. One of the primary factors or reasons for this finding is foot deformity. The prevalence of bad posture and bodily deformities in pre-school and school children is a fact which parents and teachers have to be faced with on a daily basis. Results of numerous studies indicate that the largest prevalence of deformities in orthopedics is the deformities of a particular segment of foot and spinal column. The causes of the postural disorder may be congenital and acquired, internal and external, topological, social, psychological, environmental and so on. Also, it is well known that hypokinesia is manifested as an ultimate result of both the increased standard of living and decreased physical activity. During their leisure time, the majority of children reduce their physical activities to the minimum only to play computer games and use their PC. Such lifestyle endangers other vital functions as well. The postural status of children population of this age is exposed to great risks. Bad posture is the result of poor phylogenetic adaptability to the upright posture, and weak skeleton and muscle structure. When diagnosing the postural

status in children, it is, among other things, necessary to establish their foot status. The feet may be evaluated in a number of ways. Certainly, the most detailed information is provided during podoscopic examination using the computerised and digitalised podography (CDP) method which has been applied in this study.

### **Objectives and tasks**

The aim of this programme and study was to reconstruct and establish the functioning of the initial postural status, that is foot status in pre-school children, and to present the obtained results before the relevant institutions in order to provide much needed preventive treatment. In order to meet the goal, the following tasks had to be performed:

- Making a diagnose in order to establish the initial (current) feet status in terms of correct or potentially deformed feet;
- Planning – to determine major directions (of tasks and goals) to be followed by children during a specified time interval; the directions are set depending on the established initial (current) feet status in pre-school children;
- Programming – to establish the means and methods for the

implementation of the planned corrective measures under specific conditions and with the application of adequate loads in particular segments of physical exercise (organised corrective exercise) and time intervals.

## Methods

The study has been implemented in the "Radosno detinjstvo" kindergarten institution in the territory of the City of Novi Sad. A total of 559 children were included using the random choice method. The children were divided into two sub-groups based on the gender criterion. The boys group included a total of 287 boys aged 4-6 years; the girls group included a total of 272 girls of the same age. The variable pattern included the following: body height (TELVIS); body weight (TELMAS); collapsed transversal arch (PESTRAN); generalised joint laxity (CALVAL); high arch foot (PESCAVUS); four degrees of pes planus – pes planus 1 (PP1); pes planus 2 (PP2); pes planus 3 (PP3); pes planus 4 (PP4); and foot without deformity (BO). The foot deformity was measured by using the computerised and digitalised

podography (CDP) method; the podoscope device consists of a box with a glass top illuminated by fluorescent lights, a digitalised video camera, a PC with a video card, adequate software, and color printer. The main features of CDP are the following:

- measures and records the pressure points of the patient's feet in both static and dynamic mode;
- shows the calibrated values of the exerted pressure;
- shows the examined foot in time intervals;
- generates the image of the maximum exerted pressure;
- prints diagnostic reports.

The measurements were made and interpreted by competent professionals capable of both diagnosing the foot deformity and creating the foot deformity correction programme.

## Results

The obtained results of this study are presented in the form of tables and graphs. First we are going to deal with numerical (n) and percent (%) of occurrences of the evaluated deformity types.

Table 1. Occurrence of the evaluated PES TRANSFERSOPLANUS foot deformity

|   | Deformity |       |  |
|---|-----------|-------|--|
|   | w/o       | with  |  |
| n | 39        | 520   |  |
| % | 6.98      | 93.02 |  |

Table 2. Occurrence of the evaluated CALCNEO VALGI foot deformity

|   | Deformity |       |  |
|---|-----------|-------|--|
|   | w/o       | with  |  |
| n | 41        | 518   |  |
| % | 7.33      | 92.67 |  |

Table 3. Occurrence of the evaluated PES PLANUS 1 foot deformity

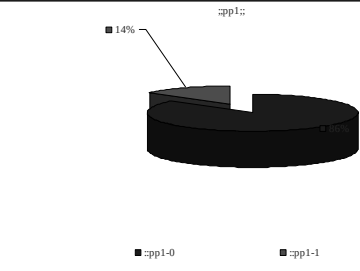
|   | Deformity |       |                                                                                    |
|---|-----------|-------|------------------------------------------------------------------------------------|
|   | w/o       | with  |                                                                                    |
| n | 482.      | 77.   |  |
| % | 86.23     | 13.77 |                                                                                    |

Table 4. Occurrence of the evaluated PES PLANUS 2 foot deformity

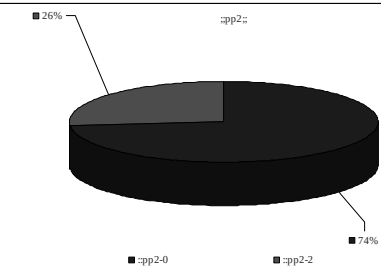
|   | Deformity |       |                                                                                    |
|---|-----------|-------|------------------------------------------------------------------------------------|
|   | w/o       | with  |                                                                                    |
| n | 412       | 147   |  |
| % | 73.70     | 26.30 |                                                                                    |

Table 5. Occurrence of the evaluated PES PLANUS 3 foot deformity

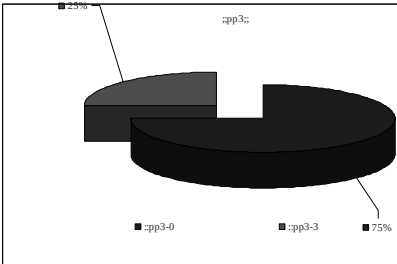
|   | Deformity |       |                                                                                      |
|---|-----------|-------|--------------------------------------------------------------------------------------|
|   | w/o       | with  |                                                                                      |
| n | 420       | 139   |  |
| % | 75.13     | 24.87 |                                                                                      |

Table 6. Occurrence of the evaluated PES PLANUS 4 deformity

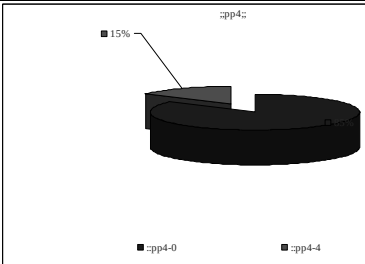
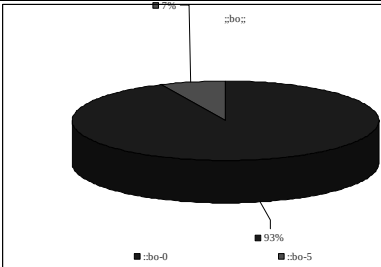
|   | Deformity |       |                                                                                      |
|---|-----------|-------|--------------------------------------------------------------------------------------|
|   | w/o       | with  |                                                                                      |
| n | 473       | 86    |  |
| % | 84.62     | 15.38 |                                                                                      |

Table 7. Occurrence of the evaluated WITHOUT DEFORMITY status

|   | Deformity |      |                                                                                      |
|---|-----------|------|--------------------------------------------------------------------------------------|
|   | with      | w/o  |                                                                                      |
| n | 520       | 39   |  |
| % | 93.02     | 6.98 |                                                                                      |

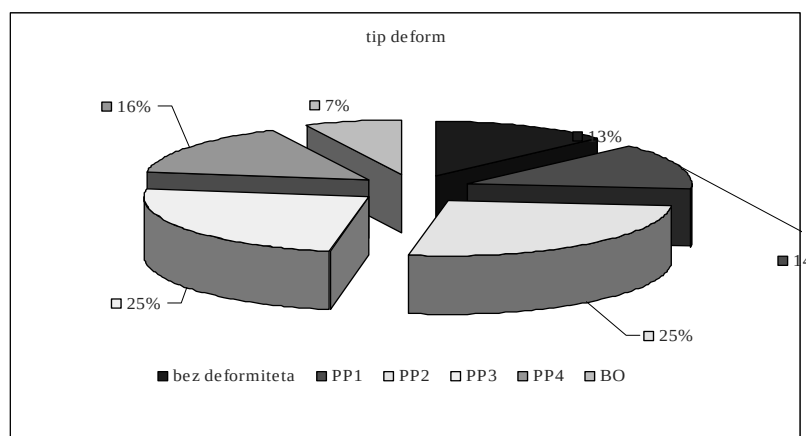


Figure 1. Occurrence of flatfoot deformity types in the overall sample

Table 8. Numerical (n) and percent (%) of occurrence of deformity types per gender

|       | w/o deformity |      | PP1 |      | PP2 |      | PP3 |      | PP4 |      | BO |     |
|-------|---------------|------|-----|------|-----|------|-----|------|-----|------|----|-----|
|       | n             | %    | n   | %    | n   | %    | n   | %    | n   | %    | n  | %   |
| Boys  | 32            | 11.1 | 25  | 8.7  | 79  | 27.5 | 76  | 26.5 | 55  | 19.2 | 20 | 7.0 |
| Girls | 40            | 14.7 | 51  | 18.8 | 68  | 25.0 | 62  | 22.8 | 32  | 11.8 | 19 | 7.0 |

Table 8 shows that the most frequent deformity in boys was PP2, reported in 79 cases (27.5%) out of a total number of 287 boys, which is a significantly higher number of cases when compared with PP4 which occurred in 55 cases (19.2%),  $p=.018$ . The absence of pes planus deformity is recorded in 32 cases (11.1%),  $p=.000$ ; PP1 occurred in 25 cases (8.7%),  $p=.000$ , whereas no deformity (BO) was reported in 20 cases (7.0%),  $p=.000$ .

As for girls, the occurrence of PP2 was reported in 68 cases (25.0%), which is a significantly higher number of cases when compared with the occurrence of PP1 reported in 51 cases (18.8%),  $p=.078$ . The absence of any pes planus deformity was reported in 40 girls (14.7%),  $p=.003$ ; PP4 was reported in 32 cases (11.8%),  $p=.000$ , and no deformity (BO) was reported in 19 girls (7.0%),  $p=.000$ .

The difference regarding gender of the examined children: no pes planus deformity is a diagnose more frequently made in the *girls* group (14.71%); PP1 is also more frequent in the *girls* group (18.75%); its occurrence is significantly higher than in the *boys* group (8.71%,  $p=.001$ ). PP2 is the most common deformity in the *boys* group (27.53%); PP3 is also more frequent in the *boys* group (26.48%); PP4 is more frequent in the *boys* group (19.16%) as well, where

its occurrence is significantly higher than in the *girls* group (11.76%,  $p=.016$ ). The importance of the differences between the genres (boys and girls), when examined against the 4 evaluated feet deformity types, is shown.

Table 9. The significance of the differences between the genres with regard to evaluated deformity types

|        | N | F     | P    |
|--------|---|-------|------|
| MANOVA | 4 | 4.574 | .001 |

Since the established statistically significant difference is  $p = .001$ , the conclusion is that there is a significant genre difference between the examined children with regard to the evaluated deformities.

Table 10. Mahalanobis distance between the examined genres with regard to evaluated deformity types

|       | Boys | Girls |
|-------|------|-------|
| Boys  | .00  | .36   |
| Girls | .36  | .00   |

If we take an integral view of both genre flatfoot deformity patterns, the obtained results presented in Table 10 show that the Mahalanobis distance between the two examined genres, boys and girls, is smaller.

## Discussion and conclusion

Table 1 shows that PES TRANSVERSOPLANUS occurred in the great majority of the examined pre-school children (520 deformity cases, 93.02%), whereas only 7% of the examined children of the same age had no foot deformity. The CALCANEO VALGI deformity (Table 2) occurred in the majority of the examined pre-school children, almost 93%. This alarming data also tell us that only 7% of the examined children did not suffer from generalised joint laxity. The first degree collapse of the medial longitudinal arch, PES PLANUS 1 occurred in 14% of children (Table 3). When compared with other flatfoot deformities, PP1 was most infrequent. Table 4 shows the number and percentage of children suffering from the second degree pes planus (PP2). Some 26% of the examined children suffered from this particular deformity. Pes planus 2 is the most frequent medial longitudinal arch collapse deformity. The occurrence of the collapsed longitudinal arch of third degree is almost the same as the collapsed longitudinal arch of second degree, almost 26% (Table 5).

The result indicates that these two deformities are the most common ones in pre-school-aged children because such deformities affected almost 50% of the examined children population. Some 15% of the examined children population (Table 6) suffered from the most severe longitudinal arch collapse known as Pes planus 4. Only 6.98% of the examined children population (Table 7) was without any flatfoot deformity, which is an alarming finding for this specific population. Graph 1 shows the occurrence of the collapsed longitudinal arch deformity classified in the above mentioned four degrees. Using the CDP method, a total of 559 children were examined.

Their feet deformity status was evaluated against 10 possible deformity types, among which 5 were reported as most significant (PP1, PP2, PP3, PP4 and BO) for the establishment of the initial posture status of pre-school children. The obtained results were presented both as tables and graphs. Based on the relevant statistical procedures it may be concluded that in the examined children population 93.02% of children had deformed feet, and only 6.98% had normal feet. When speaking about the degree of pes planus deformity, the most infrequent flatfoot deformity was PP1 (14%) whereas the most frequent flatfoot deformity was PP2 (26%).

Based on the obtained results, it is possible to outline some gender characteristics in terms of prevailing deformity types: the boys had insignificant prevalence of PP2, PP3 and PP4; the girls had insignificant prevalence of *without deformity*, PP1 and BO. Since  $p = .003 \chi^2$  – of the test, and  $\chi = .175$  with the confidence interval (.099; .252) that does not contain a zero, it may be concluded that gender and deformity type are not tightly related. If we observe the sub-groups created on the gender criterion, it may be concluded that the frequency of PP1 in boys was lower than in girls (8.71%, 18.75%, respectively); however, the frequency of PP4 in boys was higher than in girls (19.16%, 11.77%, respectively). In the *girls* group the frequency of PP1 was higher than in the *boys* group (18.75%, 8.71%, respectively); however, the frequency of PP4 in girls was lower than in boys (11.77%, 19.16%, respectively). Also, it may be concluded that the difference between the examined genres in terms of the evaluated deformities are statistically significant ( $p = .001$ ) and that there is a clearly defined line between the two genres. Hence, it is possible to establish genre characteristics in terms of evaluated deformities.

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## UTVRĐIVANJE INICIJALNOG STANJA SVODA STOPALA KOD DJECE PREDŠKOLSKOG UZRASTA

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### Sažetak

Jedan od primarnih faktora tj. razloga nezadovoljavajućeg posturalnog statusa predškolske djece je deformitet stopala. Veliki postotak deformiteta predškolske i školske populacije je činjenica sa kojom se roditelji i pedagoški radnici susreću svakodnevno. Djeca se u najvećoj mjeri odmaraju pasivno uz mikropokrete vezane uglavnom za tehničke aparate tipa video igara i kompjutera. Posturalni status djece u ovom uzrasnom periodu izložen je velikom riziku. U ovom istraživanju utvrđen je deformitet stopala predškolske populacije dječaka i djevojčica uzrasta od 4-6 godina metodom KDP tj. kompjuterizovane digitalizovane podografije. Cilj je bio da se izvrši konstrukcija i funkcionisanje inicijalnog modela posturalnog statusa – stopala predškolske djece i da dobiveni rezultati budu predstavljeni odgovarajućim relevantnim institucijama kako bi se pružila neophodna preventivno-kurativna pomoć. Na osnovu dobijenih rezultata može se zaključiti da veliki broj ispitivane djece posедуju deformitete stopala, čak 93%, dok je bez ikakvog deformiteta svega 7%.

**Ključne riječi:** inicijalno stanje, deformitet, stopalo, djeca

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## THE INFLUENCE OF SOME ANTROPOLOGICAL FEATURES ON SPECIFIC TESTS WITH YOUNG BASKETBALL PLAYERS

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*Original scientific paper*

### **Abstract**

*According to the 68 entities, of 16 years old males, it has been realized the morphological aspect of consisting 10 tests, the motile aspect consisting four specific tests as criterion. If we consider the results of this experiment, we can conclude that it is achieved the main objective of this experiment. As far as the morphological aspect is concerned, all variables have realized relevant correlations. In addition, the aspect of motile tests has realized most of the significant correlations. In the procedure of the regressive analysis have been examined the influence of the testing in the manifesto field and prediction of the results of motile tests through morphological and predictable test. From the tests treated as connection criterion, regressive importance with morphological tests have shown the tests such as, free hitting, throwing with a jump, dribble and hitting in the cage, and going and coming dribble that shows resistance in speed. Finally, we have the persuasive tests, where the explosive force and specific speed are the main significant factors to guide the players in a basketball game. Even, the exactness dimension represents an important dimension in the basketball game because the main purpose of this game is to score as much as possible in order to win the game.*

**Key words:** *basketball, regression, explosiveness, speed, winning*

### **Introduction**

Even in nowadays, basketball game is one of the favorite games for most of the people especially for young people. These young people enjoy the devotion towards this preferred sport. As time goes by, it raises the number of people who express interest to learn, enjoy and relax while experiencing this game.

Considering the experiments that we have done until now, we can say that fulfilling different motile tasks depend on the structure of the morphological dimensions. We know this because by focusing on other experiences, the presentation of this problem in explorative, scientific, and methodological terms turns to be the main point for defining the structure of the anthropological status of young people. The aim of this experiment is noticing some relevant and morphological characteristics as predisposition and specific criteria. In other words, the aim of this research is to verify the characteristic connection between the morphological and motile tests concerning basketball players. In fact, it aims to verify some specific mobile tests considered as criterion in morphological tests as predisposition.

### **Methods**

The experiment covers 68 entities of young males, around 16 years old, who have been practicing basketball in the city of Prishtina. The testing is done during January until February of 2008. Furthermore, the morphological tests have been done during the morning hours, whereas the mobile tests have been done during the basketball practice time. The all tests have been done in the sports center. There are set three hypotheses considering this experiment, which can be read as it follows. The first one is the significant correlations that exist between morphological variability tests. Next, I suppose that there are correlations between motile variability of basic and specific tests. Finally, there is valuable and regressive connection between the morphological, mobile, and specific tests as criterion. The results are elaborated in the following programs, SPSS version 16, 0 and statistics version 5, 0 of windows. The analyses are done in the manifesto areas. In order to set the morphological area, it has been applied 10 tests, which are: body weight (AAW), body height (AAH), hand length (AHL), leg length (ALL), foot length (AFL), palm length (APL), palm width (APW), arm perimeter (AAP),

thigh perimeter (ATP), femur perimeter (AFP). In the motor area, it has been applied 4 situated mobile tests (criteria). The situated tests were: dribble by hitting in the cage (SDC), free hitting (SFH), hitting the cage with a jump (SHJ), going and coming dribble (SDR).

### Results and discussion

If we look at the correlative matrix between morphological variables in the first table, we can notice that from 45 possible coefficients of the correlation, only 32 coefficients are relevant or 75 %. In the first group belong the tests, which determine the longitudinal dimension of the skeleton. These are, body height, hand length, leg length, and foot

length, which realize the correlation with the high values of 61-80, whereas the palm width, as a pointer for transversal dimension, realizes the correlation with the lowest value of 54-61. This can be explained through the fact where the test that shows the transversal dimension is loaded with error variation. Additionally, this has the value lower in relation with other tests. In the second group belong the tests that determine circular dimension which are the arm perimeter, thigh perimeter, femur perimeter, and body weight.

The body weight with the correlation coefficient has the value from 70 -71, hence, the high correlation of the body weight in the two groups can be explained as a linear combination of many variables.

Table 1. Correlation of the Morphological Tests

|     | AAW  | AAH  | AHL  | ALL  | AFL  | APL  | APW  | AAP  | ATP  | AFP  |
|-----|------|------|------|------|------|------|------|------|------|------|
| AAW | 1.00 | 0.70 | 0.79 | 0.79 | 0.60 | 0.23 | 0.56 | 0.30 | 0.34 | 0.47 |
| AAH |      | 1.00 | 0.57 | 0.56 | 0.40 | 0.19 | 0.52 | 0.63 | 0.65 | 0.69 |
| AHL |      |      | 1.00 | 0.71 | 0.59 | 0.13 | 0.47 | 0.25 | 0.24 | 0.38 |
| ALL |      |      |      | 1.00 | 0.50 | 0.20 | 0.55 | 0.19 | 0.31 | 0.43 |
| AFL |      |      |      |      | 1.00 | 0.04 | 0.48 | 0.21 | 0.15 | 0.25 |
| APL |      |      |      |      |      | 1.00 | 0.12 | 0.16 | 0.02 | 0.15 |
| APW |      |      |      |      |      |      | 1.00 | 0.37 | 0.36 | 0.40 |
| AAP |      |      |      |      |      |      |      | 1.00 | 0.65 | 0.60 |
| ATP |      |      |      |      |      |      |      |      | 1.00 | 0.67 |
| AFP |      |      |      |      |      |      |      |      |      | 1.00 |

If we look at the correlative matrix in the table, we can notice that from 45 of possible correlative coefficients, 20 of them or 44 % are important. These important correlations are realized by the tests such as: the jump from the main spot to a distance, the jump from the main spot to highness, and the 20 meters running, with a high value of -.47-.75.

The test called throwing the medicinal ball in a distance does not realize correlation with the test of 20 meters running, with low value of .25- -.29. The test called throwing the ball in a distance, realizes correlation with the test of high jump and throwing the medicinal ball with optimal value of .29- .53. The next test for the strength of the stomach muscle does not realize correlation with two tests but it has connection with other tests with optimal value of -.35- -.48. Furthermore, the dribble by hitting in the cage, has correlation with the tests as it follows, the jump from the main spot to a distance, the jump from the main spot to highness, the 20 meters running and

the test for the strength of the stomach muscle, with the value from -.32- -.50. The test called hitting through a jump, has correlation with only one test, which is the jump from the spot to a distance with a low value of .24-.28. Finally, the test going and coming dribble realizes correlation with the following tests, the jump from the main spot to a distance, the jump from the main spot to highness, throwing the medicinal ball in a distance, the test for the strength of the stomach muscles, and dribble by hitting in the cage with optimal value of -.27- -.46.

In the third table are shown the results of the regressive analysis, where as a criteria are applied the motile tests. Here we have the ball dribbling and hitting in the cage, whereas as a predicates are used the morphological tests. According to the multiple correlation value which is .38, might be explained the common variability of the predictable system and criterion variability in the level of importance of  $P = 0.000$ .

*Regression analyses*

Table 1. dribble by hitting in the cage (SDC)

|     | Beta  | P    |
|-----|-------|------|
| AAW | 0.29  | 0.03 |
| AAH | 0.17  | 0.14 |
| AHL | -0.30 | 0.00 |
| ALL | -0.29 | 0.00 |
| AFL | 0.17  | 0.03 |
| APL | 0.09  | 0.13 |
| APW | -0.14 | 0.08 |
| AAP | -0.26 | 0.00 |
| ATP | -0.11 | 0.25 |
| AFP | 0.31  | 0.00 |

R= .38073835 R<sup>2</sup>= .14496169  
 Adjusted R<sup>2</sup>= .11317588  
 F(10,269)=4.5606 p<.00001

Table 2. free hitting (SFH)

|     | Beta  | P    |
|-----|-------|------|
| AAW | -0.04 | 0.78 |
| AAH | 0.04  | 0.75 |
| AHL | -0.09 | 0.39 |
| ALL | 0.04  | 0.66 |
| AFL | -0.13 | 0.11 |
| APL | 0.15  | 0.02 |
| APW | 0.26  | 0.00 |
| AAP | 0.05  | 0.59 |
| ATP | 0.03  | 0.76 |
| AFP | 0.04  | 0.65 |

R= .35512081 R<sup>2</sup>= .12611079  
 Adjusted R<sup>2</sup>= .09362420  
 F(10,269)=3.8819 p<.00006

Table 3. hitting the cage with a jump (SHJ)

|     | Beta  | P    |
|-----|-------|------|
| AAW | 0.35  | 0.01 |
| AAH | -0.36 | 0.00 |
| AHL | -0.15 | 0.14 |
| ALL | 0.03  | 0.80 |
| AFL | -0.04 | 0.61 |
| APL | 0.07  | 0.28 |
| APW | 0.13  | 0.11 |
| AAP | 0.21  | 0.02 |
| ATP | 0.01  | 0.91 |
| AFP | 0.05  | 0.61 |

R= .30857466 R<sup>2</sup>= .09521832  
 Adjusted R<sup>2</sup>= .06158331  
 F(10,269)=2.8309 p<.00232

Table 4. going and coming dribble (SDR)

|     | Beta  | P    |
|-----|-------|------|
| AAW | 0.00  | 0.98 |
| AAH | 0.24  | 0.04 |
| AHL | -0.24 | 0.02 |
| ALL | -0.10 | 0.33 |
| AFL | 0.10  | 0.22 |
| APL | 0.11  | 0.08 |
| APW | -0.09 | 0.23 |
| AAP | -0.04 | 0.64 |
| ATP | -0.23 | 0.01 |
| AFP | 0.10  | 0.29 |

R= .29648705 R<sup>2</sup>= .08790457  
 Adjusted R<sup>2</sup>= .05399768  
 F(10,269)=2.5925 p<.00513

Concerning the predictable variables, the highest value is shown by the body height, hand length, leg length, foot length, arm perimeter, and femur perimeter. From this, we can conclude that the tests that have the biggest influence should be considered during the orientation and selection of young children for the basketball game. The results, in the forth table show that according to the coefficient value of the multiple correlations .35, it can be explained the general variability of the criterion variable in order to influence the predictable test, whereas the other part of the variability can be interpreted with the help of other factors of the anthropological status.

From the predictable tests, the highest values are shown by the palm length and breadth, as indicatory tests of the preciseness of the hitting in the cage, where preciseness is a sensible motile dimension. According to the results in the fifth table, the coefficient value of the multiple correlations .31 is possible for a general explanation of the variables with influence in the predictable system. From the predictable tests, the highest value has created the following tests such as, body height, body weight, and the arm perimeter. By being based in the sixth table, we can notice the coefficient value of the multiple correlations .30, refers that the general variability of the criterion test can be explained with the influence of the predictable variable system, where the left part of the variability can be explained with the help of the other factors of the anthropological status. From the predictable variables, the highest values have shown the following tests: the body weight, hand length and thigh perimeter.

## Conclusion

Concerning this experiment there are three hypotheses, where the first hypothesis is partially proved because according to the results, only ten morphological tests have realized correlation with optimal value. In addition, the second hypothesis is partially proved in relation with the optimal value of the motile and specific tests. Finally, in the third hypothesis, according to the regressive analysis and achieved results, we can conclude that this hypothesis is proved entirely, because there have been four motile and specific tests as criteria, achieved through the predictable and morphological system. According to the 68 entities, of 16 years old males, it has been realized the morphological aspect of consisting 10 tests, the motile aspect consisting four motile and specific tests as criterion, and six other basic tests. If we consider the results of this experiment, we can conclude that it is achieved the main objective of this experiment.

As far as the morphological aspect is concerned, all variables have realized relevant correlations. In addition, the aspect of motile tests has realized most of the significant correlations. In the procedure of the regressive analysis have been examined the influence of the testing in the manifesto field and prediction of the results of motile tests through morphological and predictable test. From the tests treated as connection criterion, regressive importance with morphological tests have shown the tests such as, free hitting, throwing with a jump, dribble and hitting in the cage, and going and coming dribble that shows resistance in speed. Finally, we have the persuasive tests, where the explosive force and specific speed are the main significant factors to guide the players in a basketball game. Even, the exactness dimension represents an important dimension in the basketball game because the main purpose of this game is to score as much as possible in order to win the game.

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## UTJECAJ NEKIH MORFOLOŠKIH DIMENZIJA NA SPECIFIČNE MOTORIČKE TESTOVE KOD MLADIH KOŠARKAŠA

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### **Sažetak**

*S uzorkom od 68 entiteta uzrasta 16 godina muškog spola, realizirano je istraživanje morfološkog aspekta od 10 varijabli uz 4 specifična motorička testa koji su poslužili kao kriteriji. Na temelju rezultata bilo je moguće zaključiti da je ostvaren cilj eksperimenta. Sve morfološke varijable su pokazale značajne korelacije. Nadalje, motorički testovi su pokazali značajne relacije. Regresijskom analizom je utvrđen utjecaj prediktivnih morfoloških mjera na rezultate motoričkih testova. Posebno su značajni testovi: slobodno bacanje, skok-šut, dribling i šut iz reketa kao i dribling kao mjera održavanja brzine kretanja s loptom. Konačno, imamo uvjerljive pokazatelje, gdje eksplozivnost i specifična brzina predstavljaju glavne faktore koji vode igrača u košarkaškoj igri. Štoviše, ove dimenzije predstavljaju dominantne sposobnosti u košarci jer ostvaruju glavnu svrhu igre a to je pogađanje što predstavlja pretpostavku pobjede.*

**Ključne riječi:** košarka, eksplozivnost, brzina, pobjeda

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## RELATIONS OF THE BASIC FEATURES OF THE SAMPLE WITH THE SUCCESS IN FREE CLIMBING

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*Original scientific paper*

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### **Abstract**

*The aim of this paper was to determine relations of the basic features of the sample with the success in free climbing. The research was conducted on 20 male subjects from Serbia, Bulgaria and Rumania competing Naissus route climbing challenge 02 held in 2008 in Jelasnica mountain. On the basis of the obtained results it can be concluded that the basic features of the sample are a good predictor for the success in free climbing. Also, it can be concluded that junior climbers more fit for this season (climbed harder route this season) would be better ranked at the free climbing competition.*

**Key words:** *basic features of the sample, free climbing*

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### **Introduction**

Sports climbing nowadays is a very complex sport with its own terminology and equipment generated after the decades of experimenting. For several years it has been considered the most popular and most attractive "leisure" sport with the biggest increase of membership in the world. (Creasy & all., 1999). In the Balkans area this is relatively new sport so very few researchers have conducted their studies in the area of this extremely complex sport. However, on the international level body of research on this sport and experiments conducted on climbing population is enormous one. To be more precise, regarding success in free climbing were researched in the following studies. Wats, Martin and Durtschi (1993) have measured anthropometric variables in 39 semifinalists in the World cup in sports climbing just before the competition. They have concluded that the elite sports climbers are of short to medium height, have very small percentage of body fat, have medium hand shake strength, and big relation strength-weight ratio when compared to the non-athlete population. When these results are compared with the results of other sports disciplines athletes it is stated that stamina and height-weight relation of the elite sports climbers are similar to the values recognized in long distance runners, marathon runners and ballet dancers, but different from the values found in body builders and elite gymnasts. When compared to elite gymnasts elite sports climbers have bigger ectomorphy (bigger height-weight relations).

In discussion researches claim that bigger ectomorphy is an advantage in climbing due to reduction of total weight. Mermier, Janot, Parker and Swan (2000) have researched physiological and anthropometric parameters connected to sports climbing. The study comprised 44 climbers (24 male and 20 female subjects) of different climbing expertise and different climbing experience. Subjects have climbed two different routes in two days. Routes (11 and 30 meters long), were located on an artificial rock and were so designed to make progressive difficulties from the start to the finish. Marking was administered according to the rules governing competitions in weight climbing. Following anthropometric, demographic and physiological variables were used. Regression analysis was applied to find the results stating that the number of training sessions has significantly influenced the success in mastering these two routes. They have also stated that climber do not have determined and specific anthropometric composition that will enable their better climbing. Binney i Cochrane (2003) have tested a sample of 8 women and 10 men aged  $26,9 \pm 6,2$  and  $30,1 \pm 3,6$ , elite sports climbing competitors at the end of four-month competing season. The following was tested: maximal isometric power, crimp grab power (MVC) in relation to the body mass, endurance of crimp grab at 60 and 40 % MVC, specific climbing endurance of the lower arm muscles and body composition. Success in sports climbing was represented by the mean value of the total season result.

The results pointed to the fact that the specific climbing endurance of the lower arm muscles is a key factor in success in mail competitors. Variable that was also a significant predictor was a percentage of body fat in female subjects. (reverse proportion). Other variables were not statistically significant in influencing sports climbing competition success. Binney i Cochrane (2003) have tested climbing trajectory as a global variable of the sports climbing form. The research was conducted in 4 competitions (2 national and 2 international ones) on a sample of 72 competitors, aged  $21,9 \pm 5,4$ . Competing climbing form was estimated according to the standings taken at each competition (as a criterion the highest point reached on the rock was taken). By means of digital camera each climbing was recorded and trajectory was drawn with the moves of fixed point on the competitors back in the wrist. Correlations searched were those between competing climbing form and trajectory length. Results have shown that the trajectory length is not a significant predictor of the competing climbing form in sports climbing competitors. Wats, Joubert, Lish, Mast and Wilkins (2003) have investigated anthropometrics of young sports climbers on a sample aged 13, 5 (3, 0) that have given their consent to take part in the investigation.

The following test were applied: height, weight, body mass index, (BMI), hand diameter, bicrystal and biacromial distance of skin folds on 9 anatomic points, lower arm circumference and hand shake firmness. Control group was made of 45 subjects going in for other sports like basketball, cross running, ski cross running, football and swimming. They have concluded that young sports climbers in general have similar anthropometric characteristics as the old ones (comparing with Wats, Martin, and Durtschi, 1993). This includes relatively short built, smaller body mass, small skin folds and high values of hand shake firmness in relation to the body mass. When compared to the athletes, non-climbers of the same age climbers show more linear body type, with narrower shoulders in relation to hips. There are also differences in body composition between the climbers and athletes, non-climbers except in body mass index.

Schweizer and Furrer (2007) have researched correlations of lower arm power and success in sports climbing by means of three different movements of lower arm muscle on 25

recreational climbers (climbers who could climb O.S. 6b+ to 7c and R.P. 7a to 8b+). For the testing sake a special isokinetic device was designed for the estimation of maximal excentric and concentric strength of wrist flexion, flexsion of the proximal interfalangal joint of the middle and index finger, and the movement including both interfalangal joints and metakarpafalangal joints of all fingers. There was no correlation between absolute maximal strength and success in sports climbing. Relative strength, however, in all three tests has statistical significant correlation with climbing difficulty at *Red Point* and *On Sight*, apart from proximal interfalangal flexion and O.S. climbing. Correlation coefficients were highest between R.P. and maximal excentric and concentric strength of wrist flexion. Researchers in the end conclude that of all lower arm muscles the best predictor of the climbing success was concentric flexion of the wrist joint. The aim of the paper is to determine the relations of the basic features of the sample with the success in free climbing.

## Methods

The subject sample for this research was drawn from the sports climbing competitors population from Serbia, Bulgaria, and Rumania, all competing on the federal and international level, aged 17 to 35. 20 male subjects were investigated. They took part in Naissus route climbing challenge 02 competition held in 2008 in Jelasnica gorge. Sample comprised all willingly stated competitors. Competition routes for the competition Naissus route climbing challenge 02 (24 routes) and the organization were identified by the author and M.Puletic (one of the best sports climbers in Serbia), organized by PK Naissus from Niš and SPK Gekon from Belgrade, under the auspices of the Ministry of Youth and Sport and the Mountaineering Association of Serbia.

Refereeing and scoring was administered by the educated referees in sports climbing rectified by the Mountaineering Association of Serbia, and observed by the author himself. Scoring rules were taken from the site [www.8a.nu](http://www.8a.nu) contain the world list of sports climbers on the natural rocks without on-sight climbing, except for the projects). So as to provide the same chances for fair scoring routes were first explained by the organizers of the referees on the spot. Difficulty levels of routes ranged from VI (5c) and X (8b).

Scoring:

| Grade           | Points | Style, Score & Bonus points                    |
|-----------------|--------|------------------------------------------------|
| X+ (8b+)        | 1150   | On Sight (O.S.) – Jump three grades - 5 points |
| X (8b)          | 1100   |                                                |
| X- (8a+)        | 1050   | Flash (F) – jumps one grade + 3 points         |
| IX+/X- (8a)     | 1000   |                                                |
| IX+ (7c+)       | 950    | Second Go (2Go) – +2 points                    |
| IX (7c)         | 900    | First ascent (F.A.) – +10 points               |
| IX- (7b+)       | 850    | On Sight (O.S.) – Jump three grades - 5 points |
| VIII+/IX- (7b)  | 800    |                                                |
| VIII+ (7a+)     | 750    |                                                |
| VIII (7a)       | 700    |                                                |
| VIII- (6c+)     | 650    |                                                |
| VII+/VIII- (6c) | 600    |                                                |
| VII+ (6b+)      | 550    |                                                |
| VII (6b)        | 500    |                                                |
| VIII- (6a+)     | 450    |                                                |
| VI+/VII- (6a)   | 400    |                                                |
| VI+ (5c+)       | 350    |                                                |
| VI (5c)         | 300    |                                                |
| .....           | .....  |                                                |

#### Variable

##### General sample parameters

- |                                 |      |
|---------------------------------|------|
| 1. Age                          | AGE  |
| 2. Sports experience            | SPEX |
| 3. Body height                  | BH   |
| 4. Body mass                    | BM   |
| 5. Body mass index              | BMI  |
| 6. Hardest climbed route        | HCR  |
| 7. Hardest climbed route season | HCRS |

##### Criterion variable

- |                         |      |
|-------------------------|------|
| 1. Competition standing | CSTD |
|-------------------------|------|

##### Test description:

Hardest climbed route means the score for the hardest climbed route that any subject

has climbed in his/her scoring career. This grade is in the form of a number according to the international table of scoring and route grading. Hardest climbed route this season means the score for the hardest climbed route that any subject has climbed that season until the competition. This grade is in the form of a number according to the international table of scoring and route grading. Competition standing comprises sum of 10 hardest climbed routes climbed by a climber in all three competing days. In case the climber did not climb 10 routes, all climbed routes were marked.

## Results and discussion

Table 1. Descriptive statistics

| Variable | Mean  | Min   | Max    | Range | SD     | Error | Skew. | Kurt. |
|----------|-------|-------|--------|-------|--------|-------|-------|-------|
| AGE      | 25.2  | 17.0  | 35.0   | 18.0  | 4.97   | 1.11  | 0.07  | -0.48 |
| SPEX     | 6.4   | 1.0   | 18.0   | 17.0  | 3.76   | 0.84  | 1.37  | 3.79  |
| BH       | 181.2 | 174.0 | 190.0  | 16.0  | 5.05   | 1.13  | 0.51  | -0.80 |
| BM       | 71.7  | 64.0  | 85.0   | 21.0  | 6.74   | 1.51  | 0.79  | -0.52 |
| BMI      | 21.9  | 18.0  | 26.2   | 8.2   | 2.15   | 0.48  | 0.08  | -0.52 |
| HCR      | 787.5 | 300.0 | 1050.0 | 750.0 | 178.35 | 39.88 | -1.03 | 1.67  |
| HCRS     | 705.0 | 300.0 | 1000.0 | 700.0 | 175.39 | 39.22 | -0.07 | 0.28  |

Table 2. Correlations

|      | AGE  | SPEX  | BH    | BM    | BMI   | HCR   | HCRS  | CSTD |
|------|------|-------|-------|-------|-------|-------|-------|------|
| AGE  | 1.00 |       |       |       |       |       |       |      |
| SPEX | 0.72 | 1.00  |       |       |       |       |       |      |
| BH   | 0.15 | 0.25  | 1.00  |       |       |       |       |      |
| BM   | 0.31 | 0.54  | 0.19  | 1.00  |       |       |       |      |
| BMI  | 0.22 | 0.38  | -0.39 | 0.83  | 1.00  |       |       |      |
| HCR  | 0.35 | 0.30  | 0.32  | -0.24 | -0.42 | 1.00  |       |      |
| HCRS | 0.20 | 0.18  | 0.26  | -0.41 | -0.53 | 0.93  | 1.00  |      |
| CSTD | 0.05 | -0.07 | -0.31 | 0.31  | 0.48  | -0.86 | -0.89 | 1.00 |

Table 3. Relations of the basic features of the sample with the competition standing

| Variable | R     | Part-R | Beta  | Std.Err. | t(12) | p-level |
|----------|-------|--------|-------|----------|-------|---------|
| AGE      | 0.05  | 0.59   | 0.35  | 0.14     | 2.53  | 0.03    |
| SPEX     | -0.07 | -0.10  | -0.05 | 0.16     | -0.34 | 0.74    |
| BH       | -0.31 | 0.25   | 1.11  | 1.26     | 0.88  | 0.39    |
| BM       | 0.31  | -0.27  | -2.03 | 2.07     | -0.98 | 0.35    |
| BMI      | 0.48  | 0.26   | 2.05  | 2.23     | 0.92  | 0.38    |
| HCR      | -0.86 | -0.28  | -0.32 | 0.32     | -1.00 | 0.34    |
| HCRS     | -0.89 | -0.54  | -0.68 | 0.31     | -2.20 | 0.05    |

$$R = .9542 \quad R^2 = 0.9106 \quad F(7,12) = 17.461 \quad p < 0.00002$$

Analyzing Table 1 showing the results of the central and dispersion parameters of the applied variables of the general characteristics of competitors it can be stated that all results of arithmetic means are valid because standard err. of the arithmetic means in all variables is always more than five times smaller than its own arithmetic means. Values of the basic, central and dispersion parameters of the applied variables in the intervals of the minimal (min) and maximal (Max) results comprise always about 4 or more standard deviations (SD), which enables us to state significant sensibility of all applied tests. There is also optimal skew (symmetry) of distribution in the zones around the arithmetic means (Skew). From the Skewness one can also notice that there is greater number of climbers with longer climbing experience (SPEX) and somewhat smaller number of good results in the variable the most difficult climbed route (HCR). However, Kurtosis (Kurt.) whose value in most variables is significantly smaller than 2,75 means that the test results are largely scattered. This does not come as a surprise because here the sample of subjects contained heterogeneous age representatives.

Only in the variable sports experience one can notice homogeneity of the results. Out of the basic statistical parameters one can also notice that the population out of which the sample was taken is relatively high (mean value 181, 24) which is in contrast with the investigation conducted by Wats & al, (2003). This can indicate towards the agreement with Mermier & all. 2000 who claim that climbers do not have determined anthropometric composition that enables them to climb better. Analyzing matrix of correlation (table 2) it can be concluded that a small number of coefficients is significant on the level of 95% in the range of 0,48 to 0,93.

## Discussion

The biggest correlation coefficients have variables hardest climbed rout and hardest climbed route this season (0,93), than hardest climbed rout and hardest climbed route this season with competition standing (-0,89 i -0,86) and body mass index with body mass (0,83). The lowest statistically significant correlation coefficient is between body mass index and competition standing (0,54). In table 3 results of the connection of variable system for the estimation of the basic features of the sample with success in free climbing (competition standing) are shown. By the analysis of the obtained results it can be stated that there is statistically significant connection between system of the basic features of the sample and competition standing ( $p < 0,00002$ ). Connection of the whole system with criterion variable explains very high coefficient of multiple correlation  $R = 0,95$ , which in turn explains common variability between system and criterion variable with about 91% ( $R^2 = 0,91$ ). Analysis of the regression coefficients of each basic features of the sample shows that there is statistically significant connection of the criterion variable competition standing with age (AGE) with the significance of 0,0264 and the hardest climbed route this season (HCRS) 0,0484. The rest basic features of the sample: sports experience, body height, body mass, body mass index and hardest climbed route, have not statistically significant connection with criterion variable competition standing. On the basis of the obtained results it can be concluded that the basic features of the sample are a good predictor for the success in free climbing. Also, it can be concluded that junior climbers more fit for this season (climbed harder route this season) would be better ranked at the free climbing competition.

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## RELACIJE TEMELJNIH ZNAČAJKI UZORKA ISPITANIKA S USPJEHOM U SLOBODNOM PENJANJU

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### Sažetak

Svrha ovog članka je da ukaže i postavi temelje relacija osnovnih svojstava uzorka entiteta s uspjehom u slobodnom penjanju. Istraživanje je provedeno na 20 muških ispitanika iz Srbije, Bugarske i Rumunjske koji su se takmičili na Naissus penjačkoj ruti climbing (challenge 02) održanom 2008 na Jelasnica gorge. Temeljem dobivenih rezultata zaključeno je kako su osnovna svojstva ispitanika dobar prediktor uspjeha u slobodnom penjanju. Također, može se zaključiti da su omladinci bolje pripremljeni ove sezone (penju težu rutu) pa je za očekivati i njihovu bolju ranking poziciju.

**Ključne riječi:** temeljne sposobnosti, slobodno penjanje

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## THE EFFECTS OF THE PROGRAMMED TRAINING ON THE TRANSFORMATION OF THE QUALITATIVE LEVEL IN THE SITUATIONAL-MOTOR SKILLS WITH HANDBALL PLAYERS AGED 11-14

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*Original scientific paper*

### Abstract

82 young handball players, all of them in a training process at least one year, aged 11-14, underwent a three month programmed transformational procedure. Basic principle of this procedure was situational methods. Structurally – qualitative changes of the situational-motor skills in the structure of the relations are significant. Two latent specific movement mechanisms are isolated, with 73% of common variability. Se we are safe to assume that a large number of the variability in the specific tests is implemented, where as a criterion Guttman-Kaiser is taken, these two factors describe the essence of handball: 1) movement and controlling the court, and 2) achieving the goal (scoring). Analysis of the structural changes, done with the Cramer model with the more accurate identification, shows the biggest changes in variables SMGLC (hitting the mark with a ball) and SMŠZ20 (throwing the ball against the wall), so we can conclude that this procedure affects Accuracy and Speed of movement without a ball. The general conclusion stemming from this analysis suggests that this handball program made significant changes in the structure of the situational-motor skills.

**Key words:** handball, transformation, changes

### Introduction

Creating players is a long-term, arduous and complex task, a procedure which requires completion of many demands along the process. For those reasons in the pyramid of monitoring, valuating and the control of the effects of the training, younger categories must take precedence and must rely on quality, in order for the transformation processes to have their projections in future work. Kinesiology and the appliance of the sport technology tells us that 10-15 or more years is needed for a top handball result to be produced. Handball players reach their maximum at the ages 22-25 or more. We can conclude that the period of the preparation for one handball player is marked with long preparations, numerous resources, material demands, and the help from specialists in various activities and disciplines. The goal of this enormous task is a total development of the future player, capable of reaching the ultimate level. As this analysis is pointed towards future, initially we must acquire at least the global parameters and rules so as to program a successful transformational procedure. Motor skills are one of the basic factors to determinate the success of the player.

Each situation that occurs during the game must be realized in training, and this realization with the loco motor system is possible because of the players' strength, stamina, accuracy, speed, coordination, balance and agility. The activities of the handball players are based on general motor abilities, which allow acquiring of the knowledge of the specific situational technical and tactical elements, relevant for the success. The main goal in handball is to score, and that process very much depends on the cooperation among the teammates. The team, based on the optimal technical and tactical efficiency, functions as a specific system of cooperation, structurally based on individual players acting as a personal communication net. The activities of the players are based on general motor skills, which allow gaining the knowledge from specific situational, technical and tactical elements, relevant for the success. Based on relevant researches (Pavlin, Šimenc & Delija, 1982), we can assume that there are 5 latent situational dimensions: the accuracy at hitting the inanimate target, ball handling, speed of movement with a ball, speed of movement without a ball, and shooting power.

## Problem and aim

The focus of this work is: transformational processes of the situational-motor skills in handball players aged 11-14. Kinesiology researchers are interested the most in transformational processes in certain periods of time and with strictly defined contents. The tendency is to determine the factors which are decisive in achieving of the certain results in sport, but also to be transformed to a satisfying degree, and that is the reason why this age is selected. The problem in this work represents evaluating of the qualitative changes in the situational-motor skills caused by the training program. The goal of this work is to evaluate the changes in situational-motor skills of the players who were following programmed training process.

## Methods

For the purpose of this research, using the longitudinal approach, the situational-motor skills and all the changes during the period of three months were followed. This research involves 82 handball players aged 11-14. The players were members of the following clubs: RK "Ilidža" Ilidža, RK "Olimpik" Sarajevo, RK "Vogošća" Vogošća, RK "Goražde" Goražde. The players underwent medical examinations, and were all physically healthy, without obvious morphological or locomotive defects. The only criterion which they had to fulfill was that they are in a training process for at least one year.

For the evaluation of the situational-motor skills, the tests used for the evaluation of the young players in Italy, Russia, Slovenia, and Germany were used. The sample test entails five latent factors which are responsible for the situational efficiency in handball: 1) Speed of movement with a ball- handling the ball in a slalom (SMVLS), 2) Accuracy- hitting the target with a ball (SMGLC), 3) Throwing power- throwing the ball while moving (SMŠLD); 4) Speed of movement without a ball-running the triangles with the basic defensive position (SMTOS), and 5) Handling the ball- throwing against the wall for 20 seconds (SMŠ20).

In order to determine qualitative and structural differences in situational-motor skills the most appropriate methods were applied: LSDIF model, CRAMER model, QDIFF1 model and KRZANOWSKY model (Bonacin, 2004)

## Results and the Discussion

Table 1. Retained individual values according to GK criterion (the first measurement)

| N | L    | P    | P CUM |
|---|------|------|-------|
| 1 | 2.47 | 0.49 | 0.49  |
| 2 | 1.16 | 0.23 | 0.73  |

(L= individual value, P= the proportion of the explained variability, P CUM= cumulative explained variance)

Table 2. Retained individual values according to GK criterion (the second measurement)

| N | L    | P    | P CUM |
|---|------|------|-------|
| 1 | 2.80 | 0.56 | 0.56  |

(L= individual value, P= the proportion of the explained variability, P CUM= cumulative explained variance)

The structural-qualitative changes of the situational-motor skills in the structure of relations are significant. In the first measurement two latent mechanisms of specific movement are isolated, and they have 73% of the common variability. So we can say that the large portion of the situational-motor variability is covered, which is clear from table 1. where as a criterion Guttman-Kaiser is taken.

Table 3. The formation and the correlation of the diagonally rotated factors in the first measurement

|      | F1    | F2    |
|------|-------|-------|
| 1VLS | 0.90  | 0.09  |
| 1GLC | -0.18 | 0.73  |
| 1SLD | -0.77 | 0.21  |
| 1TOS | 0.90  | 0.05  |
| 1S20 | 0.13  | 0.87  |
|      | F1    | F2    |
| F1   | 1.00  | -0.24 |
| F2   |       | 1.00  |

(F1-F2 = factors)

Tables 3 and 4 clearly show that the first latent dimension defines complex slalom movement with a ball (SVLS), long-distance shooting (SLD) and running the triangles (STOS). The second one describes hitting the target with the ball (SGLC) and throwing against the wall (SSOZ). It seems that we have two specific mechanisms for the regulation of the movement, where the first one is responsible for the movement in space, and the other one for shooting and throwing the projectile.

These two factors clearly describe the essence of handball in a situation where the technical level is not high (the first measurement) and after the training process. F1-movement and winning the space. The precision of hitting the inanimate target is essential because it is in connection to the situational precision in hitting the target inside the goal, and that corresponds to the precision in real game. The skill of ball handling represents the ability to easily manipulate with the ball either standing or moving. Handling of the ball should be considered a basic requirement for achieving the success in handball. The high level of preparation in ball handling enables the player to use the other, namely tactical qualities of the player. Speed of the movement with a ball, covers the space of player's movement with a ball during the attack, and in certain attacking combinations.

F2-reaching the goal (scoring). The speed of movement without a ball is a characteristic of a defensive play, in attacking play its occurrence is much less, but it is equally important. Attacking moves without a ball are: winning the ground, making yourself available, counter-attacks, and in defensive moves we have running across the court to stop the counter-attack, and different forms of covering and the destruction of the opponents' game. The throwing power is responsible for the situational explosive power of shooting. Throwing the ball in form of passing and shooting are the most common elements in handball. Shooting power is more significant in shooting on goal. Shooting power and precision are the decisive factors in scoring, so it is obvious that the throwing power is one of the determination factors in handball. The modern approach to basic and specific anthropological marks of the handball players, and to specific demands and characteristics of this game, needs scientifically based analyses and knowledge which are attainable only by using scientific research projects. This result is positive and confirms above said. Further proof is in Tables 3. and 4. where GK criterion is used. The acquired factor is integral and balanced, with the projections which tell us that all variables applied are equally involved in hypothetical final mechanism of the specific movement in handball. In Tables 5 and 6 we can see congruencies and correlations of the diagonal formations in the first and the second measurement. The matching of the factors cannot be complete, because of the different number of dimensions.

Table 5. Congruencies of the diagonal formations in the first and the second measurement

|      |    | 1.Measurement |
|------|----|---------------|
|      |    | F1            |
| PRVO | F1 | 0.84          |
| MJ.  | F2 | -0.56         |

Table 6. . Correlations of the diagonal formations in the first and the second measurement

|      |    | 2. Measurement |
|------|----|----------------|
|      |    | F1             |
| PRVO | F1 | -0.91          |
| MJ.  | F2 | 0.56           |

However, the first factor has a certain amount of continuity, while the other factor does not have that quality and it is involved in the unique dimension in the second measurement. Structures are significantly different, and programmed handball treatments will generally contribute to the understanding of the specific occurrences with the athletes. This is most probably acquired from study of the specific movement, which ultimately was a goal in this study. In that sense this result is expected and welcome, and it proves that the training treatment realized in this study had a positive effect.

Table 7. The results of the LSDIF analysis

|       |        |
|-------|--------|
| TRACE | 0.52   |
| HI-2  | 21.30  |
| DF    | 5      |
| P     | 0.0011 |

(TRACE = the real trace of the matrix of difference, HI-2 = trace hi-square function, DF = degrees of freedom, P = probability)

The results of structural changes in the model LSDIF can be seen in Table7. In Table 8 where the Krzanowsky model is applied is clearly seen that the structural changes visible across all of the variables, with a slightly lower intensity in running triangles in the defense. This is understandable, because if for the success of this research is responsible, along with the specific qualities of handball, also some functional and energetic motor attribute, then it is natural that in a group of specific movements which are learnt during the training process, such movement has a less intense specific appliance.

This results proves that there occurred restructuring of the dimensions along the entire sample of the entity, and all the variables.

Table 8. The results of Krzanowsky's

| Var.   | D     |
|--------|-------|
| SVLS   | 0.98  |
| SGLC   | 0.92  |
| SSLD   | -0.91 |
| STOS   | 0.87  |
| SSOZ20 | 0.90  |

Table 9. The results of the QDIFF1 analysis

| Var.   | S     | R    |
|--------|-------|------|
| SVLS   | 0.80  | 0.10 |
| SGLC   | 0.64  | 0.20 |
| SSLD   | 0.81  | 0.10 |
| STOS   | 0.83  | 0.09 |
| SSOZ20 | 0.73  | 0.15 |
|        |       |      |
| RO     | 0.071 |      |
| ALRO   | 0.964 |      |

S = local similarities (>0.85) and differences (R) RO = global measure of similarity ALRO = global measure of the differences

In Table 9, where CRAMER method is used with the more precise identification, the biggest changes are in variables SMGLC (hitting the target with a ball), and SMŠŽ20 (throwing the ball against the wall). This is not unexpected, because the goal is for all the other actions and movements to be successfully executed (especially with the ball). In order to achieve that, the anticipation and passing of the ball must be mastered, which is a basic requirement for playing the game, and that is the technique which was the center of attention of training process.

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Table 10. The results of the QDIFF1 analysis

| Var.   | D     |
|--------|-------|
| SVLS   | 0.12  |
| SGLC   | 0.19  |
| SSLD   | 0.09  |
| STOS   | 0.08  |
| SSOZ20 | 0.12  |
|        |       |
| G      | 0.109 |

D = local measures of changes (> 0.10, >0.15), G = global measure of changes

## Conclusion

Structurally-qualitative changes in the situational-motor skills in the structure of relations are significant. Two latent mechanisms with the specific movement are isolated, with a total of 73% of common variability. In this way we can say that a large portion of the variability of the special tests is covered. Here as a criterion Gutman Kaiser is taken. These two factors clearly describe the essence of handball: F1-movement and winning the space, and F2-reaching the goal (scoring).

Analysis of the structural changes under the CRAMER model with the more accurate identification according to which the biggest changes are on variables SMGLC (hitting the target with a ball) and SMŠŽ20 (throwing the ball against the wall), and that is: Accuracy and Speed of the movement without the ball. The general conclusion which stems from the analysis of the qualitative changes in the situational-motor skills is that after a three-month programmed handball training we can see significant changes in the structure of situational-motor skills.

## **EFEKTI PROGRAMIRANOG TRENINGA NA TRANSFORMACIJU KVALITATIVNOG NIVOA SITUACIONO-MOTORIČKIH SPOSOBNOSTI RUKOMETAŠA UZRASTA 11-14 GODINA**

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### **Sažetak**

*Uzorak od 82 mlada rukometaša, svi uključeni u trenažni proces trajanja jednu godinu, uzrasta 11-14 učestvovali su u tromjesečnom programiranom transformacijskom postupku. Temeljni princip ovog postupka bile su situacijske metode. Strukturalno-kvalitativne promjene specifičnih situaciono-motoričkih sposobnosti u strukturi relacija su bile značajne. Dvije latentne dimenzije situaciono-motoričkih mehanizma gibanja su izolirane, sa 73 % zajedničkog varijabiliteta. Tako se sa sigurnošću može zaključiti da veliki broj varijacija specifičnih testova pod Guttman-Kaiserovim kriterijem možemo svesti na dva bitna: 1) gibanje i kontrola terena, i 2) postizanje cilja (pogotka). Analiza strukturalnih promjena, urađena pod modelom Cramera s ciljem preciznije identifikacije, pokazala je najveće promjene kod pogađanja označenog cilja loptom, kao i kod bacanja lopte u zid. Na temelju toga je zaključeno da je postupak naročito angažovao preciznost i brzinu pokreta vezanih uz loptu. Opći zaključak koji se nameće iz ovog istraživanja sugerše da je rukometni program izvršio značajne efekte na strukturu situaciono-motoričkih dimenzija.*

**Ključne riječi:** rukomet, transformacije, promjene

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## CANONICAL RELATIONS BETWEEN MORPHOLOGICAL – MOTOR FEATURES IN FIRST GRADE STUDENTS

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Original scientific paper

### Abstract

*On the representative sample of 164 examinees, at the age of 7.5, from Valjevo, the system of 25 manifest variables in total has been applied, including 14 anthropometric measures and 11 motor tests. Data processing and deducing relations between morphological (predictive) and motor (criteria) variables have been executed using the bi orthogonal linear model of canonical correlation analysis. Algorithm of this multi-variation model has extracted only one pair of significant canonical functions. Achieved standardized coefficient of canonical correlation is  $R=0.77$ , it has positive tendency and relatively high intensity, on the level of statistical importance ( $p<.01$ ), while calculated value of determination canonical coefficient  $R^2=0.55$  indicates on maximal amount of 55% of explained information in relation to total variance of analyzed groups of variables. Extracted function has been defined (on the hypothetical level) as the general canonical morphological factor and general canonical morphological factor. Examining the complex latent structure of the first pair of canonical factors and their cross canonical maximal pressures, indicates on following statistical interpretation of linear correlations: if examinees have higher values in latent morphological dimensions (longitudinal dimensionality of skeleton, transversal dimensionality of skeleton, volume and body weight, and subcutaneous fat tissue), then they achieve better results in motor factors (explosive strength, flexibility, coordination of movements, static and dynamic strength of arms, repetitive strength, balance and frequency of movements), and vice versa.*

**Key words:** morphological characteristics, motor abilities, canonical function, determination coefficient, variance, canonical factor

### Introduction

Theory of integral child development (Ismail and Gruber, 1971) accentuates the complex structure of morphological – motor features of the students. Due to this fact it is necessary to identify the latent structure and all relevant relations between anthropometric features and motor abilities for the purpose of choosing the methods for standard selection in sport, hiking, control and programming of training processes, as well as successful evaluation of the development of relevant anthropological features (Kurelić, Momirović, Stojanović, Šturm, Radojević and Viskić-Štalec, 1975; Viskić-Štalec and Mejovšek, 1975; Metikoš, Gredelj and Momirović, 1979; Mraković, 1994; Blašković, 1997; Findak, 1999; Tokić and Prskalo, 1999.). During the first decade of XXI century very few researchers were drawn to problem of canonical relations between morphological and motor features in the earliest stages of students development in the class / school environment. (Malacko, 2002; Malacko and Popović, 2005; Bala, 2007; Grbavac, 2007; Blažević, Bilić,

Bonacin, Širić and Bonacin, 2007; Širić, Manić and Bonacin, 2008). Determining the significant relations between the variables of morphological and motor areas in different sexes and ages is especially important if we are aware of the very few findings which corroborate the fact that in certain motor activities one morphological structure directly prevents realization of certain kinetic activities on the one hand, while on the other hand that same body structure optimally influences execution of some other motor tasks (Kurelić et al., 1975; Viskić-Štalec et al., 1975; Malacko and Rađo, 2004). Due to this fact, it is very important to obtain (by further research) new information about statistically significant and interrelated (crisscrossed) linear correlations between latent morphological – motor specific features in students of youngest school age. In doing so, we would be able to more precisely define, control, maintain and transform the existing parameters of anthropological abilities and characteristics; leading to full understanding, planning and

execution of appropriate kinesiology diagnostic and PE curriculum's. Based on research topic thus defined, this paper sees formulation of two basic goals: (1) establishing canonical structures of morphological – motor areas, (2) determining linear correlations (direction, intensity and natural relations) between the entirety of anthropometrical and entirety of motor canonical variables. Having in mind thus defined goals, this empirical research led to hypothesis H : Expected findings - identification of canonical structure and statistically significant relations between the systems of anthropometric (predicative) variables and the set of motor (criteria) variables in first grade students.

### Methods

On appropriate sample (N = 164) of first grade students of male sex (Valjevo), a system consisting of 27 variables was applied (14 anthropometric measurements and 15 tests of motor abilities). Sample of manifested anthropometrically independent (predicative) variables was reached according to standards of IBP (International Biological Program) – *International Biological Program* (Mišigoj-Duraković, 1995) based on 14 standard anthropometric measures presented in the tables as coded: Body height (VISTEL), Length legs –height *spine iliace anterior superior* (DUŽNOG), Arm length (DUŽRUK), Shoulders span (ŠIRRAM), Pelvis span (ŠIRKAR), Wrist radius (DIJRUIZ), Knee radius (DIJKOL), Body mass (MASTEL), Forearm circumference (OBIPOD), Shank circumference (OBIPOT), Average circumference of the chest (OBIGRU), Thickness of skin fold on forearm (NABNAD), Thickness of skin fold on stomach (NABTRB) and Thickness of skin fold on the back (NABLED).

In order to evaluate motor abilities, a group of 11 manifested criteria (dependable) variables was applied: polygon backwards (POLINAT), Stepping aside (KORACS), Standing on both feet, diagonally on balance bench, eyes opened (STAJOO), touch-toe aside (PRETKR), Hand taping (TAPRUK), Foot taping (TAPNOG), Long jump from a spot (SKOUDM), Throwing a ball weighing 20 g to the distance (BAČLOP), sprint for 20 m standing start (TRČ20M), Lifting the upper body while laying on the back and with crouched legs (PODTRL) and Pulling upwards with crouch (IZDRŽV).

Defined representative sample of motor measure instruments was based on the model by Gredelj, Metikoš, Hošek and Momirović (1975). Each and every single motor task in the appropriate indicator of the structured tests was executed three times. Relations between two different, multidimensional anthropological groups of manifested variables were determined by standard mathematical – statistic principle of *Hotelling* linear canonical correlation analysis. Coefficients of canonical correlation and inter correlations between applied anthropometrical measuring and motor tests were established, as well as correlations between canonical dimensions extracted from both groups of variables. Statistical significance of canonical correlation was tested by Bartlett hi-square test ( $\chi^2$ ), and with allowed margin of error ( $p < 0.01$ ) significance of influences of manifested variables on canonical morphological factors and canonical motor factors was analysed. Results were then put through program package *Statistics for Windows*, ver. 6.0.

### Results and discussion

For interpreting the results of anthropometric features and motor tests we will use tabular excerpts from matrix showing the most representative items defined through canonical factors. Excerpts from the basic results of the analysis of canonical correlations of variables are shown in condensed form in tables 1, 2 and 3.

Table 1. Statistical significance of canonical functions

|   | CR   | CR <sup>2</sup> | $\chi^2$ | DF    | P    |
|---|------|-----------------|----------|-------|------|
| 1 | 0.77 | 0.55            | 221.17   | 64.00 | 0.01 |
| 2 | 0.39 | 0.15            | 69.86    | 51.01 | 0.33 |
| 3 | 0.79 | 0.21            | 0.03     | 48.23 | 0.54 |
| 4 | 0.78 | 0.31            | 0.09     | 21.25 | 0.97 |
| 5 | 0.92 | 0.22            | 0.01     | 8.13  | 0.91 |

Key : C R – canonical coefficient of correlation; C R<sup>2</sup> – canonical coefficient of determination or square of canonical correlation;  $\chi^2$  – Bartlett hi-square test of canonical correlations' significance; df – number of degrees of freedom p – statistical significance of canonical functions

In the course of identifying canonical relations on previously regulated and standardized data taken for 27 manifested variables, only one statistically significant and high canonical correlation was established (Table 1).

Thus established FIRST CANONICAL FUNCTION is statistically significant because its standardized coefficient of canonical correlation has got positive direction and relatively high intensity. (CANONICAL  $R = .77$ ) which qualifies it as statistically significant ( $p < .01$ ). What this actually means is that its configuration reduced many isolated non-zero linear relations between the pairs of anthropometric and motor variables to liner relations of the two canonical structures from the both groups. Determined value of the coefficient of canonical correlation points to the fact that based on large number of linear combination within both analysed groups of variables there is coherence of two structures of canonical factors in defined group of test subjects.

By solving the algorithm of characteristic matrix equation we get the canonical coefficient of determination or square of canonical correlation (CANONICAL  $R^2 = 0.55$ ). its value points to the higher quantity of 55% explainable proportion of standardized variant taken from the total variability of the analyzed variable groups. Meaning that given redundancy index as an average value of a square over multiple correlation coefficient of the one group and each and every variable from the other group, we established presence of relatively large proportion of explained information, i.e. more than  $\frac{1}{2}$  of the initial data related to total variability, which in turn proves relevance informative value of the first canonical function. Other four isolated canonical functions are given only for informative purposes and will not be considered any further because they are not significant and do not carry statistically relevant quantity of shared variables. That is to say that they do not have any influence on relations between morphological – motor canonical variables.

Statistically significant interconnection of the analyzed morphological area can be explained by the first pair of canonical functions (Table 2). It is obvious that this extracted canonical linear combination is predominantly defined by average and high values of canonical load – weight, of the positive direction and with a span varying from  $r = .37$  to  $r = .62$ . Predominant influence in saturation of the complex structure of the first pair of canonical morphological factor belongs to (according to

hierarchical values of projection) vectors of the following predicative variables with the positive sign of canonical coefficient : body height (0.81), Length legs –height *spine iliace anterior superior* (0.79) and arm length (0.76), pelvis span (0.62), shoulders span (0.54), knee radius (0.45) and ankle radius (0.39), body mass (0.66), forearm circumference (0.34), shank circumference (0.43) chest circumference (0.37), thickness of skin fold on stomach (-0.77), thickness of skin fold on the back (-0.72) and thickness of skin fold on forearm (-0.70).

Table 2. Matrix of canonical coefficient and structural vectors of canonical morph. factor

| VARIABLE | kan 1 |
|----------|-------|
| VISTEL   | 0.81  |
| DUŽNOG   | 0.79  |
| DUŽRUK   | 0.76  |
| ŠIRKAR   | 0.62  |
| ŠIRRAM   | 0.54  |
| DIJKOL   | 0.45  |
| DIJSKZ   | 0.39  |
| MASTEL   | 0.66  |
| OBIPOD   | 0.34  |
| OBPOTK   | 0.43  |
| OBIGRU   | 0.37  |
| KOŽTRB   | 0.59  |
| KONLEĐ   | 0.57  |
| KONNAD   | 0.51  |

Analysing given anthropometrical variables (equally metrically directed) and canonical coefficients which reflect part of the variable shared by the initial variable and new integrated canonical variable, it becomes clear that resulting vector of this canonical factor is represented with high canonical load (of a positive direction) of variables with latent dimensions (*longitudinal dimensionality of the skeleton, transversal dimensionality of the skeleton, mass and volume of the body and subcutaneous fat tissue*). According to the absolute values of the linear correlations with this extracted canonical factor, as well as relative participation of each predicative variable in the complex composition of the first canonical function, dimensions distributions of this interpretable latent structure of bone segments growth and body development can be interpreted (hypothetically) as GENERAL CANONICAL MORPHOLOGICAL FACTOR.

As for motor abilities (Table 3), statistically significant interconnection could be explained by the first pair of canonical function.

As shown in the table, some projections of the motor tests are considerably lower compared to morphological variables.

Table 3. Matrix of canonical coefficient and structural vectors of canonical motor factor

| VARIABLES | KAN 1 |
|-----------|-------|
| POLINAT   | -0.26 |
| KORACS    | -0.21 |
| STAJOO    | 0.24  |
| PTRETR    | 0.55  |
| TAPRUK    | 0.27  |
| TAPNOG    | 0.23  |
| SKOUDM    | 0.71  |
| BACLOP    | -0.21 |
| TRČ20M    | 0.62  |
| PODTRL    | 0.27  |
| IZDRŽV    | 0.29  |

Span of canonical coefficients which determine the first bipolar canonical dimension in this motor sphere oscillate from  $r = .21$  to  $r = .71$ . Predominant canonical loads (with the positive sign) on uniform group of hyper - ellipsoid of the resulting vector of this canonical factor have got hierarchical value compared to values of statistically significant correlations on the one hand, criteria variables like long jump from a spot (0.71), sprint for 20 m standing start (0.62), touch-toe aside (55), pulling upwards (-0.29), lifting the upper body while laying on the back and with crouched legs (-0.27), hand taping (-0.27); while on the other hand canonical loads with negative sign have got variables like polygon backwards (-0.26), throwing a ball weighing 20 g to the distance (-0.21) and stepping aside (-0.21).

In order to comprehend calculated coefficients of correlation with proportional values of the negative signs, it is necessary to clarify that the coefficients of some tests (POLINAT and KORACS) change their signs due to the structure of the motor task and the mode of registering achieved results. Items in these tests are registered according to time units, which in turn mean that test scores are better if it is accomplished in shorter time interval.

Result thus achieved has got lesser numerical values. However, it logically points to the more efficient execution of the task i.e. its realistic ranking would be on the positive pole of the extracted factors.

Analysis of resulting vector of this canonical factor of the polarized structure (different metrical directions) shows that it is defined by primary variable of hypothetical latent motor dimensions *explosive strength, dynamic arm strength, static arm and shoulders strength, repetitive strength of the upper body, speed of the alternating moves, flexibility and balance*. Having in mind relative contribution of each criteria variable in the complex composition of the configuration of first canonical function and values of linear correlation, this shared latent structure of movement regulation and realization of the kinetic chain can be hypothetically defined as GENERAL CANONICAL MOTOR FACTOR. Linear connection between isolated canonical variables (according to Kurelić and associates, 1975) is generated (hypothetically) by latent functional mechanisms of the central nervous system; mechanisms which are responsible for variety of *movement structures* (movements coordination), *synergy regulation and tonus regulation* (flexibility, speed of alternating moves and balance), *regulation of excitement intensity* (explosive strength) and regulation of excitement duration (static and repetitive strength). Analysis of the structure of interrelated correlations matrix, i.e. interrelations of cosines of angles between the vectors of the first pair of canonical factors, established existence of two latent dimensions in two different multidimensional anthropological systems of variables. They can be hypothetically interpreted as GENERAL CANONICAL MORPHOLOGICAL FACTOR on the one hand, and GENERAL CANONICAL MOTOR FACTOR, on the other hand. Considering canonical variables extracted from the results of anthropometric measuring and motor tests leads to the assumption that at the very foundation of the structure of the first pair of canonical factors (formed by predicative and criteria variables of interrelated canonical maximal loadings in multidimensional domains of anthropometrical and motor attributes) every variable influences every canonical function. This means that statistically relevant linear cross correlations between morphological and motor canonical factor can be defined (hypothetically) in the following manner: if students achieve better results within the group of adequate anthropometric measuring (body height, length legs – height *spine iliace anterior superior*, arm length, shoulders span.

Also pelvis span, wrist diameter, knee diameter, body mass, forearm and shank circumference, average chest circumference, thickness of forearm skin fold, thickness of stomach skin fold and thickness of back skin fold), than they achieve better results within the group of tests of motor abilities (polygon backwards, stepping aside, standing on both feet, diagonally on balance bench, eyes opened, touch-toe aside, hand taping, foot taping, long jump from the spot, throwing a ball weighing 20 g to the distance, sprint for 20 m standing start, lifting the upper body while laying on the back and with crouched legs and pulling upwards with crouch). It is also assumed that calculated shared variable of the first pair of canonical factors can be influenced in the opposite direction as well: if students achieve lower values in applied anthropometric measuring, they will also achieve lesser results in the set of tests of motor abilities. According to the logic of the applicable numerical algorithm of the canonical correlative analysis, results gained by this canonical study corroborated the tested hypothesis (H), which relates to identification of canonical structure and statistically significant relations between the group of anthropometrically independent (predicative) variables and the group of criteria (dependant) motor variables in first grade students.

### Conclusion

On appropriate sample (N = 164) of the test subject, males, age 7,5 ( $\pm 6$  months), clinically healthy, chosen from school population in Valjevo, a system of 27 manifested variables was applied (14 anthropometrical measuring/predicative group/ and 11 tests of motor abilities /criteria group/). In accordance to the research goal, a large number of items was interpreted using standard multivariate method of Hotelling's linear canonical correlation analysis.

Based on the value of the first extracted canonical function, i.e. standardized coefficient of the canonical correlation ( $R = .77$ ) which qualifies it as statistically significant ( $p < .01$ ) and of positive direction between the first pair of the extracted canonical factors, as well as on canonical coefficient of determination or, square of canonical correlation ( $R^2 = 0.55$ ), we were able to identify 55% of information compared to the entire variable between the two analysed multidimensional systems.

By analysing the relations of the matrix of canonical structure between anthropometric measuring and motor abilities, we were able to determine the existence of the configuration of the first canonical factor. Resulting vector out of this latent canonical structure consists of the following linear combinations of the initial predicative and criteria variables: (1) proportion of the variable which manifested anthropometric variables share with the new morphological variable - defined as GENERAL CANONICAL MORPHOLOGICAL FACTOR and (2) relative contribution of canonical coefficients of every manifested motor variable on new bipolar latent dimension, which is defined as GENERAL CANONICAL MOTOR FACTOR. Analysis of the latent structure of the first pair of canonical one -dimensional structure and its significant maximal cross canonical loadings points to the following hypothetical cause-effect explanation of the linear correlations: if students achieve higher values in primary latent morphological dimensions (longitudinal dimensionality of the skeleton, transversal dimensionality of the skeleton, mass and volume of the body and subcutaneous fat tissue ), they achieve better results in motor factors as well ( explosive strength, flexibility, coordination of movement, dynamic arm strength, static arm strength, repetitive strength, balance and speed of the alternating moves; and vice versa); decrease in values in the system of predicative morphological variables proportional mirrors decrease in the results within criteria motor variables. Given results are hard to compare due to the great difference in composition of variable groups in recent research of multidimensional morphological and motor domains.

However, they should certainly be tested in a series of new empirical studies (on valid and randomly chosen subjects and with the representative samples of variables), which would be complement those whose results were hypothetical subject of this study. Having in mind that the relations between morphological-motor variables were rarely analysed under to canonical model of linear correlation analysis, here presented data represent the contribution of this study to the research in anthropological space in first grade students. Through this study and through adequate methodological treatment of data, we offer (with the high degree of certainty and required coefficient of reliability) a hypothetical model.

That is a model of understanding the complexity of canonical structure and interrelations between the both groups of analysed anthropological features and abilities. Conclusions presented in this study can be used as initial basis for better kinesiology diagnostics, successful planning

and scheduling of class activities and transformational processes in PE classes, as well as model criteria for training processes in order to ensure positive effects on development of somatic features and motor abilities in first grade students.

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## KANONIČKE RELACIJE MORFOLOŠKIH I MOTORIČKIH DIMENZIJA UČENIKA PRVOG RAZREDA OSNOVNE ŠKOLE

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### Sažetak

Na reprezentativnom uzorku od 164 ispitanika uzrasta od 7.5 godina iz Valjeva, primjenjen je sistem od ukupno 25 manifestnih varijabli i to 14 antropometrijskih mjera i 11 motoričkih testova. Obrada podataka i utvrđivanje relacija između morfoloških (prediktorskih) i motoričkih (kriterijskih) varijabli, izvršena je primjenom biortogonalnog linearnog modela kanoničke korelacijske analize. Algoritam ove multivarijantne metode ekstrahirao je samo jedan par značajnih kanoničkih funkcija. Nađeni standardizovani koeficijent kanoničke korelacije iznosi  $R=0.77$ , pozitivnog je smjera i ima relativno visok intenzitet na nivou statistike značajnosti ( $p < .01$ ), dok izračunata vrijednost kanoničkog koeficijenta determinacije ili kvadrata kanoničke korelacije  $R^2 = 0.55$  ukazuje na količinu od 55% objašnjenih informacija u odnosu na ukupnu varijancu analiziranih skupova varijabli. Ekstrahirana kanonička funkcija definisana je (na hipotetskoj razini) kao generalni kanonički morfološki faktor i generalni kanonički motorički faktor. Razmatranje kompleksne latentne strukture prvog para kanoničkih faktora i njihovih unakrsnih kanoničkih maksimalnih opterećenja ukazuje na slijedeću statističku interpretaciju linearnih korelacija: ukoliko ispitanici imaju veće vrijednosti u latentnim morfološkim dimenzijama ostvaruju bolje rezultate i u motoričkim faktorima (eksplozivnoj snazi, gipkosti, koordinaciji pokreta, statičkoj i dinamičkoj snazi ruku, repetitivnoj snazi, ravnoteži i frekvenciji pokreta), i obrnuto.

**Ključne riječi:** morfološke karakteristike, motoričke sposobnosti, kanonička funkcija, koeficijent determinacije, varijanca, kanonički faktor

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## DIDACTIC PRINCIPLES IN SPORTS TRAINING APPLIED IN SPORTS GAMES

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*Professional paper*

### Abstract

*The didactic principles stem from the validity of the training processes as general reflection of centuries of school practice and proven specific peculiarities of training for the purpose of developing the sports practice, therefore they are formulated on a relatively high level of generalization. That prevents the general application to all the concrete problems in training. The principles cannot substitute the creative work and fulfill the role of a trainer. The number of possible concrete situation is so vast and so diverse that we cannot expect the didactic principle to answer all of them.*

**Key words:** didactics, training, principles

### Introduction

General didactic principles have a wide use in everyday life and tend to point out to the easiest ways of learning the elements of general education. The same principles have a very efficient use in sports training, but in a more complex form. The applied didactic principles found their place in sports training because sports insist on the maximum speed of movement, maximum muscle strain and maximum stamina. According to the difficulty of most of the sports disciplines, the following didactic principles can be highlighted:

1. From lesser to higher strain
2. From slower to faster movement
3. From lesser to higher stamina
4. From straightline to zigzag movement
5. From ergostatic to intermittent movement
6. To higher number of movem. per series
7. To higher number of series per training
8. From longer to shorter resting intervals

### Principles

#### 1. From lesser to higher strain

When the muscle strain manner is determined, which depends on the discipline, the beginner undergoes a process of musculature strengthening of the muscles used in that discipline the most. Every muscle strain can be dosed, so in this case every next strain can be determined according to the previous condition. Every exercise that cannot be repeated five to seven times, triggers the appearance of super-compensation in the organism, after which the exercise can be

repeated more than seven times. Then the next step is enforced, the strain is heightened to the level when the same exercise but with a higher strain cannot be repeated more than six times. After the super-compensation, this exercise too can be repeated for more than seven times, and we move on to the next level, heightening the strain until the muscle force reaches its ultimate level.

#### 2. From slower to faster movement

Almost every sport insists on the speed of movement of some body parts, or the entire body. It is not recommended to move with the highest speeds at the beginning of the course, or even at the beginning of the training. The organism 'demands' gradual build-up, because if the body moves with the highest speed immediately, lighter or heavier injuries are inevitable, and that excludes the individual from the further training process. If the injuries do not occur, it is still not recommended, because motor learning would be slower.

Our mind learns easier if the complex movements are executed in a slower manner, because between the two connected movements must pass some time, so the previous movement is memorised, and our mind is ready for the learning of the next movement (refraction). Only when a whole series of movements are combined into one move, and 'lodged' into our memory, can we move to a faster execution of that movement.

### 3. *From lesser to higher stamina*

The musculature is only a part of the machinery which is responsible for motor movement. Each motor skill relies on the energy of movement. In the case of sports training, the biggest part of energy is transferred to muscles via blood. The stamina will be higher if the number of mitochondrion is elevated in the muscle fiber, if the blood vessels are stretched with the improvement of their elasticity, if the lung capacity is improved, if the heart muscle is strengthened, if the number of red blood cells count is heightened, if the appropriate food is consumed (proteins, vitamins, minerals) for the synthesis of the energy sources needed for a muscle contraction, with the synchronization of the endocrine glands. The improvement of stamina has its natural progression, where we begin with a lesser strain, with fewer tries, shorter distances and longer resting intervals, and end with gradual strain heightening, more tries, longer distances and shorter resting intervals. As with any dosed strain, this one too is followed with a super-compensation, which manifests itself in the improvement of stamina.

### 4. *From straightline movement to zigzag movement*

There are significant technique differences between the straightline and the zigzag movement. While running on the curved line the movement stereotype is changed, the muscles work asymmetrically and there are central forces involved. When the shift of direction occurs, we feel the centrifugal force, which is an inertial force with the tendency of stopping the shift of direction. In order to shift the direction of movement, there appears the tilting of the body towards the center of spinning, which helps us to neutralize the centrifugal force to some extent. Because human body is not a homogenous system, the centrifugal force affects the individual parts of the body, too. To retain the optimal body position, it is necessary to use some additional muscle groups. In order for centrifugal force not to move our head to the outer side of the curve, the rotating muscles set in the neck and in the head are involved. In order for this force not to move the outer hand to the outer side, shoulder-joint muscles are used. In order not to move the inner arm to the outer side of the curve, which would cause the contact between that arm and the chest cavity

shoulder-joint muscles from the inner hand are used. In order for the centrifugal force not to move the outer leg, when it is in a phase of swinging, the hip muscles of the outer leg are used. In order for centrifugal force not to move the inner leg, when it is in a phase of swinging, to the outer side of the curve, which would lead to the contact with the outer leg, the hip muscles of the inner leg are used. It is sufficient to mention only these basic differences in dynamic stereotype, in order to understand that zigzag running is a special movement, technically a lot different from the straight-line running. Same goes for the other types of movement on a curved line, such as skating, skiing, roller-skating, cycling, etc... If in a training program the change of movement direction is a significant part of the dynamic stereotype, then the change of movement direction is meticulously trained. First we start with the change of direction while moving slowly and in a big arch, and we finish with a change of direction while moving fast and in smaller arches.

### 5. *From ergostatic to intermitent movement regime*

Sports games have a significant place in the family of sports. Running has the most prominent role in the content of the sports games. Since the sports games are very dynamic, change of places on the court must be executed in shortest period possible, basically it must happen before the opponent gets there. The result of the sports game largely depends on the speed of movement on the court.

Each sports game lasts too long and human organism is not capable of running at full speed the entire time. For that reason, each game has an intermitent regime. Intermitent regime is changing of the speed of movement from fastest to slowest, depending on the conditions on the court and the current role of the player in question. Intermitent regime of movement is highly demanding and requires a high oxygen consumption, so this regime has its procedure on the path towards the improvement of the players abilities insports. Basic principle of training is to start with the ergostatic movement with long-distance runs and with a lesser number of slow running long-distance runs. In the next sequence of training the speed of movement is gradually increased, slow long-distance runs are shortened, and their number is increased.

#### 6. From lower to higher number of movements per series

Anaerobic capacities in sports games are increased if the training is executed in parts which are organized in series. It is already mentioned, the result of the game largely depends on the speed of the movement. In most of the sports games, depending on the size of the playing ground, the average length of one sprint is 15 meters. In the initial phase of the preparations the length of the run is twice the size of the average length, and the speed of movement is twice as slower.

As the training progresses the length of the run is shortened, as well as the number of runs, but the speed is gradually increased until the maximum speed is reached.

#### 7. From lesser to higher number of series per training

This training principle is directly connected to the previous. In the previous method we pointed out that the lengths of the runs are shortened as well as their number, and accordingly, the consumption of the oxygen is less in the latter stages.

Since in the training process progressive strain is insisted on, in the course of preparation for the competitive season, the number of series is gradually increased, so the maximum consumption of oxygen increases as the preparations are developing.

The choice of exercises and the programming of the strain should be in accordance to the results of testing, so at the end of the preparations each individual reaches its maximum anaerobic-lactate and anaerobic-alactate capacity.

#### 8. From longer to shorter resting intervals

It is in human nature to adjust to the different regimes of life. Seen that in sports games the regime is highly demanding, it has to be prepared accordingly. One of the significant factors is recovery speed. In one game, one player covers long distances running in full speed, and the result is decreasing of his anaerobic capacities, and accordingly a longer recovery time is needed in order to be capable of new sprints. The result of the game basically depends on the speed of recovery. If the speed of recovery is prolonged, better trained opponent will get to the ball sooner, and that has a negative effect on the final score. The speed of recovery between the series is improved, if in the period of preparations, in the course of the entire medium cycle, in the intermittent regime resting periods are shortened gradually.

### Conclusion

The principles of training as a system are not yet definitely affirmed. The individual principles reflect only the important conditions regarding the efficiency of the training regime, while the system of didactic principles ought to cover basic testimonies in training conduction which are necessary for its success. It is clear that the set of didactic principles cannot cover the entire theory of training, its typical characteristics, the trainer-player relations, as well as the each individual training procedure, with a large number of the unexpected situations, both objective and subjective in nature. The principles have a significant level of generalization and in that way they express the basic relations more thoroughly, so their correct use in training require a certain aptitude on the part of the trainer.

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## DIDAKTIČKI PRINCIPI U SPORTSKOM TRENINGU PRIMIENJENI U SPORTSKIM IGRAMA

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### **Sažetak**

*Didaktički principi proizlaze iz zakonitosti procesa treninga kao uopćeni odrazi višestoljetne školske prakse i provjerenih specifičnih sredstava treninga u uslovima razvoja sportske prakse, pa su formulisani na relativno visokom nivou poopćavanja. Zbog toga se oni ne mogu uvijek odnositi na sve konkretne probleme treninga niti ih mogu sve obuhvatiti. Principi ne mogu zamijeniti stvaralački rad i aktivnost trenera. Broj mogućih konkretnih situacija je toliko veliki i tako raznovrstan da od didaktičke teorije i njenih principa nije moguće tražiti i očekivati odgovore za svaki pojedinačni slučaj.*

**Ključne riječi:** *didaktika, trening, principi*

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## PARTIAL AND GLOBAL QUANTITATIVE CHANGES OF MOTOR ABILITIES IN FOOTBALL PLAYERS 14 TO 16 YEARS OF AGE

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Original scientific paper

### Abstract

*This research work was carried out on the sample group of 137 football players, 14 to 16 years of age from football clubs in the area of Central Bosnian Canton. The research applies a set of 15 tests of motor abilities, which determine velocity, explosive and repetitive strength, coordination and flexibility. The basic aim of the research was to determine the partial and general quantitative changes that developed as a result of programmed training activities over a period of six months. The analysis of possible changes (differences) between the initial and final measurements of motor abilities has been performed using T-test for dependent sample and discriminative analysis. On the basis of obtained values of the T-test it has been established that significant positive changes (partial transformational quantitative effects) in all the variables applied in the field of motor abilities developed as a result of the applied programmed training activities. On the basis of obtained values of discriminative analysis it has been established that there occurred statistically significant general quantitative changes in the field of motor abilities; the most important refer to repetitive strength, flexibility and segmental velocity of lower extremities. On the basis of obtained values of the T-test for the dependent samples and the values of discriminative analysis it can be concluded that statistically significant positive changes (partial and general quantitative transformational effects) in all the variables of motor abilities developed as a result of the applied programmed training activities.*

**Key words:** motor abilities, football program, T-test, discriminative analysis.

### Introduction

Recently, the development of new training technologies has become quite visible, especially in the segment of work with the younger selections of football players. New training technology means the development of such training programs which will completely be adjusted to the age characteristics and individual abilities of every individual and as such contribute to the finest development of all characteristics and abilities which define anthropological status of an individual through all phases of his development. The existing researches have shown that human abilities and characteristics develop most effectively when the dynamic of training process concurs with the dynamic of natural development of certain characteristics and abilities. Thus, a quiet number of researchers agree with this statement (Blažević, 1997, Matvejev, 2000, Malacko 2002, Mikić 1991, Višnjić and associates. 2004), who furthermore emphasise that those are the periods of ontogenesis when, based on the natural laws, actualizes the most important dynamics of development of certain characteristics and abilities of every individual as well as the period of creating appropriate

presumptions for the formation of certain motor skills. For that reason, in the process of training program with the younger selections of football players effective procedures should be followed which help in defining the choice, dosage and distribution of training operators during the workout as well as the recovery measure during the cessation phase. Thus, by following this approach in programming training procedures it is possible to expect positive transformational effects.

The effects of training transformational processes of motor abilities have been the subject matter of recent researches: (Hadžikadunić, 2000, Talović, 2001, Stanković, 2002, Bašinac, 2002, Skender, 2004, Tabaković, Turković, Skender, 2005). In most of those researches significant partial and global quantitative changes have been established in tests of motor abilities under the influence of certain programs. In this particular research especially defined football program has been tested which lasted for six months consisting of 72 training units. The basic aim of this research was to establish partial and global quantitative changes of motor abilities originated under the influence of football program applied.

## Methods

### Samples

In this research a sample population consists of 137 football players 14 – 16 years of age from the area of Central Bosnian canton. They are all registered members of the following cadet clubs: NK "Travnik" – Travnik, NK "Vlašić" – Turbe, NK "Iskra" – Bugojno, NK "Radnik" – Donji Vakuf, FK "Vitez" – Vitez, NK "Vitez" – Vitez, NK "Novi Travnik" – Novi Travnik, NK "Lašva" – Dolac n/L (Travnik). The whole sample group has undertaken a medical check up and they were all clinically healthy and without distinctive morphologic and loco motor damages.

### Variable

For the assessment of motor abilities tests are used to measure the following: explosive strength, velocity, repetitive strength, coordination and flexibility. All the above mentioned motor abilities are tested with three tests which are standardized and available in publications. Explosive strength (Standing jump – MFESDM, Vertical jump – MFESVM, Standing long jump – MFETRO), Velocity (Leg tap – MBFTAN, Leg tap against the wall – MBFTAZ, 20 m sprint high start – MFE20V), Coordination (Leg slalom with two balls – MKLSNL, Sideway steps – MAGKUS, "Envelope" test – running in the rectangular – MAGTUP), Repetitive strength (Pushups – MRESKL, Lifting the body from laying position for 30" – MRCDTZ, Crotchety – MRSCUC), Flexibility (Forward bend on the bench – MFLPRK, Step out – MFLBOR, Split lying on the back – MFLPLU).

### Methods of data analysis

To establish partial quantitative changes (differences) for each variable used, T- test has been used to assess the changes for dependent variable which appeared in between two time points (during the initial and final measurement). To establish global quantitative changes (differences) that originated in between two time points (during initial and final measurement) the discriminative analysis has been performed.

## Results and discussion

Analyzing the results of T-test in the field of motor tests it could be noticed that the results of arithmetic median (Mean) in final

measurement are improved compared to the initial measurement, at each variable used to assess motor abilities. Based on the result of arithmetic median (Mean) in the beginning and at the end of realization of football program as well as significance and changes of (p) tested (T-test) it could be noticed that football program applied has initiated partial changes (effects) at each variable used, while the values of (T-test) have been significant at the level  $p=0,01$ . Analyzing the values of arithmetic median (Mean) in initial and final measurement we could notice that the greatest improvement of the results in final measurement occurred at following tests of motor abilities: MFETRO, MFESDM, MFESVM, tests that measure explosive strength; MKLSNL, MAGKUS, tests of coordination and flexibility tests: MFLPRK, MFLPLU. Further analysis of significant changes (p) tested (T-test) we can notice that at each test of motor abilities where improvements are visible in final measurement of values of arithmetic median (Mean) certain statistical changes occurred, i.e., they reached the values of statistical significance (p). Thus, all variables of motor abilities, tested with T-test, reached the coefficient of statistical significance (p), showing that significant statistical partial changes occurred in all variables. Based on the obtained parameters it could be stated that significant changes have been attained (partial quantitative transformational effects) in all variables in the field of motor abilities, as a result of football program applied. Based on the results mentioned in table (1) the changes have been analyzed between initial and final measurement of quantitative effects of football program in the field of motor abilities. Analysis of the results in table (1) shows us that one statistically significant discriminative function has been obtained whose coefficient of canon correlation is  $R_c=51$ , which indicates the correlation of gathered data based on which we have performed the discriminative analysis and gained results of discriminative function. To assess the efficiency of football program applied in the beginning and at the end of the program 15 tests have been performed which are considered to be valid for the evaluation of motor space. Reviewing the results in table (1) it could be noticed that the greatest contribution to discriminative analysis gives the test that measure explosive strength (MFESDM), test of repetitive strength (MRESKL), segment velocity (MBFTAN), and the flexibility test (MFLPLU). Based on the correlations of discriminative function (the

structure of discriminative function), i.e. the variable that differentiates between initial and final measurement, it could be noticed that the test for the evaluation of repetitive strength (MRESKL) is responsible for the changes obtained, and it is followed by test for the assessment of flexibility (MFLPLU), segment velocity of lower extremities (MBFTAN), coordination (MKLSNL), explosive strength (MFETRO, MFESVM), and tests of repetitive strength (MRCDTZ, MRSCUC).

The above mentioned motor tests have influenced the obtained effects caused by football program applied. Based on the presented results we can state that the football program with its structure which is based on situation training module with distended exercises has produced positive results in the increase of repetitive strength, and then flexibility and segment velocity of lower extremities. Also, significant global quantitative changes have occurred in tests of repetitive strength, flexibility and segment velocity. Test for the evaluation of running speed (MFE20V), which in this sample group is mostly dependent on genetic code, does not produce significant quantitative changes, and from that we can deduce two conclusions: a) recent researches indicate that motor abilities are mostly depended on genetic code, so it leaves a little chance for such changes to occur, and b) the structure of the program applied was not prepared in such way to cause significant changes in this motor ability.

Also, a different position of tests can be noticed on discriminative functions between (MFLPLU) and (MFLBOR), which hypothetically belong to the same ability – flexibility. Better position of (MFLPLU) test on discriminative function can be ascribed to bigger number of motor activities within the program structure which caused motor activities similar to. Global quantitative changes of some variables in motor space are the result of significant increase of efficiency in a number of body abilities, especially of increased number of specific motor information within the time limit of football program.

Table 1. The results of discriminative analysis of motor abilities

| Eigenvalue | Canonical R |
|------------|-------------|
| 0.342      | 0.505       |

| Wilks' Lambda | Chi-square | df | Sig.  |
|---------------|------------|----|-------|
| 0.745         | 77.770     | 15 | 0.000 |

Table 2. Structure of discriminant function

|        | Function 1 |
|--------|------------|
| MFESDM | -.538      |
| MFESVM | .163       |
| MFETRO | .340       |
| MBFTAN | .408       |
| MBFTAZ | -.098      |
| MFE20V | .227       |
| MKLSNL | -.392      |
| MAGKUS | -.247      |
| MAGTUP | .150       |
| MRESKL | .416       |
| MRCDTZ | .327       |
| MRSCUC | .127       |
| MFLPRK | .115       |
| MFLBOR | .111       |
| MFLPLU | .441       |

Table 3. Group centroids

| VAR00001 | Function 1 |
|----------|------------|
| 2        | 1          |
| 1,00     | -.583      |
| 2,00     | .583       |

## Conclusion

The establishing of partial global and motor quantitative changes (differences), applied motor abilities of football players 14-16 years of age from the area of Central Bosnian canton, after the realization of specially defined football program which lasted for six months, was the basic aim of this research.

Based on the results of T-tests for dependent samples and results of discriminant analysis it is possible to conclude that after the realization of specially defined football program which lasted for six months, we have reached statistically significant quantitative changes (differences) in the field of motor abilities.

The obtained results can be used by football trainers in constructing similar programs and their implementation in everyday football practice.

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## PARCIJALNE I GLOBALNE KVANTITATIVNE PROMJENE MOTORIČKIH SPOSOBNOSTI NOGOMETAŠA UZRASTA 14 DO 16 GODINA

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### Sažetak

Istraživanje je provedeno na uzorku od 137 nogometaša uzrasta 14 do 16 godina iz nogometnih klubova Srednjobosanskog kantona. U istraživanju je primijenjen skup testova motoričkih sposobnosti za procjenu eksplozivne snage, brzine, repetitivne snage, koordinacije i fleksibilnosti. Osnovni cilj istraživanja bio je da se utvrde parcijalne i globalne kvantitativne promjene (razlike) motoričkih sposobnosti nastalih pod uticajem programiranog trenažnog rada. Za analizu eventualnih promjena (razlika) između inicijalnog i finalnog mjerenja motoričkih sposobnosti primijenjen je T-test za zavisne uzorke i diskriminativna analiza. Na osnovu dobijenih parametara testiranih T-testom utvrđeno je da su dobijene značajne pozitivne promjene (parcijalni transformacioni kvantitativni efekti) kod svih primijenjenih varijabli u prostoru motoričkih sposobnosti, kao rezultat primijenjenog programa nogometa. Na osnovu dobijenih rezultata diskriminativne analize utvrđeno je da je došlo do statistički značajnih globalnih kvantitativnih promjena u prostoru motoričkih sposobnosti, a najznačajnije promjene su se desile u testovima repetitivne snage, fleksibilnosti i segmentarne brzine donjih ekstremiteta. Na osnovu rezultata T-testa za zavisne uzorke i rezultata diskriminativne analize može se zaključiti da su utvrđene statistički značajne pozitivne promjene (parcijalni i globalni kvantitativni transformacioni efekti) kod svih varijabli motoričkih sposobnosti kao rezultat primijenjenog programa nogometa.

**Ključne riječi:** motoričke sposobnosti, program nogometa, T-test, diskriminativna analiza

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## THE POSITION OF PROJECT MANAGERS IN A FUNCTIONALLY STRUCTURED SPORTS ORGANISATION

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Original scientific paper

### Abstract

Based on the principles of classical organisational theories, knowledge from the management, sports theories and general theories from different areas, a virtual sports club has been designed, in a way that it contains all of the related functions and the individual roles needed for reaching a goal in sports and making a profit. According to the basic idea, the function determined the structure, and considering that the characteristics of the functioning structured organization are: high level of specialization, strict division, clear chain of command, narrow control range, centralization and high formalization, which as a result produced the rigidity of the structure. In order to gain flexibility inside the inter-sector shifts of responsibilities, as well as the time component-occasion, two project managers were introduced, and the goal of this essay is definition of their roles in an organization structured as such. Further on, all of the individuals inside the structure are presented with an individual functional status in order to cover all the necessary functions by which all the individual roles were defined. The total number of entities gained is 205, and the number of global character variables used is 40. The taxonomization of the data using the Uditax model for the identification of the distinct taxons was executed. The results have shown that in the space of an entity there are six taxons, and what is inherent to the results of the taxonomic analysis is the existence of only three elements of the higher structure: logistics (management), support (maintenance), and sports section (the product). The results have shown that the introduction of the project managers in the structure of the organization was not crucial for the functioning of the sports organization. The structure in that way gained some flexibility, and to a positive extent the rigidity of the hierarchy was removed both internally and externally, but the project managers exist as an integral part of the logistics sector.

**Key words:** organization, structure, project managers, position

### Introduction

According to the available literature the project as a term can be defined as a complex, short-term endeavor focused on the goal that needs to be reached with limited human and material resources in the given period of time (<http://vets.bizhat.com>), in other words as a means for the organization of the related activities in a given sequence in order to achieve the pre-set goals in a given period of time (Alić-Kostešić, 2008). According to Jovanović (2004), the elements comprising the content of each project are: *the goals* to be achieved (connected mostly to the vision and the strategy of the project, supporting the global goals, defined clearly and concise), *deadlines* (the goals of the project must be reached in given timeframe), *the complexity* (considering the technology with which the goals are reached), *volume and nature of the task* (the appropriate realization plan is needed), *resources* (people,

equipment, materials...), *organizational structure* (project team and project team manager with certain responsibilities and authorizations), *information and control system* (gathering the information, following and creating the financial reports) (Gutjahr, Strauss & Toth, 2000). The critical elements of the project are: *resources* (people, equipment, materials...), *timeframe given and the sources available for the project* (Alić-Kostešić, 2008). The management of the project represents a scientifically based and in practice confirmed concept, with which rational coordination of all the necessary resources and actions is done in the most efficient way. (<http://vets.athost.net>). Project management can be defined as a an appliance of knowledge, skills, tools and techniques for the implementation of project activities that lead towards the fulfillment of the project demands, which represents a key tool in the adjustment to constant changes, for according

to Drucker, in the companies of the future there are only the fast managers, and the dead managers. (Ćala, 2008). The implementation of the strategic management via projects enables among other things maximum possible returns with the optimal usage of resources, and the competitive advantage with the placement of the adequate products at the right time. The management of each organization must shift its focus towards people, their potentials and the constant and sustainable development as a basic resource of the organizational flexibility and success (Alić-Kostešić, 2008). The project manager as a part of human resources inside the organization, is in charge of reaching the planned goals of the project; gathering, processing and distribution of the data; creating the appropriate working atmosphere; communicating with the involved personnel; and planning and making the decisions. The importance of the definition of the project manager's role is unquestionable, especially in the area of restructuring (Dekkers, 2008), or the adequate involvement of the human resource potentials (Price, 1987; M'Pherson & Pike, 2001).

### **Problem and aim**

Sports organization is only one aspect of organizing the people inside the social system, but it does not make it any less complex compared to other structures. It can be formed in different ways, but this project is based on a classical approach by which the function determines the structure. However, the characteristics of the functioning structural sports organization are: high level of specialization, strict division, clear chain of command, narrow control range, centralization and high formalization (Šoš, 2002), which as a result produced the rigidity of the structure, which is not recommended in today's shifting and unstable world. The problem of this project is determining the solution for this problem. In order to gain flexibility inside the inter-sector shifts of responsibilities, as well as the time component- occasion, *two project managers were introduced*, and the goal of this essay is definition of their roles in an organization structured as such.

### **Methods**

In the functional organizational structure each functioning unit manages a certain functional area, but for the organization as a whole.

There are common goals (sports results and profit), the division of work depending on the area to which that individual belongs, that tells us that there is a hierarchy of responsibilities and commands from the top to the bottom of the structure, the range of management and vertical and horizontal coordination and communication.

In the existing classic model coordinators are introduced on a medium level (project managers), whose controlling function does not have a permanent character, and is only shown in the peculiar short-term situations (building of the sports centre, or selling two players for a big profit; anything that does not require the complete board, but a project team of a limited size and limited goals), so it is an occasional occurrence. Project managers and the relations they manage are introduced for three reasons: a) a certain flexibility is needed, b) to harmonize the functions of the different sectors, but not the top of the commanding chain, but the inter-sector transfer of the parts of authority when the situation allows, and c) time component is relevant-it is needed only from time to time. After the completion of the hypothetical structure, all of the individuals in the structure are given an individual functional status in order to cover all the necessary functions. This model automatically defined the individual roles. The total number of entities is 205, from that number there are 26 first-line managers, 7 second-line managers and 4 third line managers. The employees are all the others (players, people employed in different areas and departments, etc.).

The sample of the variables is generated in the widest context in order to arbitrarily describe (on the manifested and the latent level), and to discover information significant for the possible optimization. The value of the sample variables was 40. The initial number of variables was over 80, but after the insight in the structure of the data, the number was cut to 40. While constructing the variables, the tendency was for the information to be in the range from 1-5, except when the variable represented counting of the obvious phenomena. All the evaluation was done by three competent evaluators (the author of this work and another two doctors of kinesiology) and the linear combination of their statements (particles) was reduced after the rounding to a whole number equal to the initial range (Bonacin Da., 2008 a).

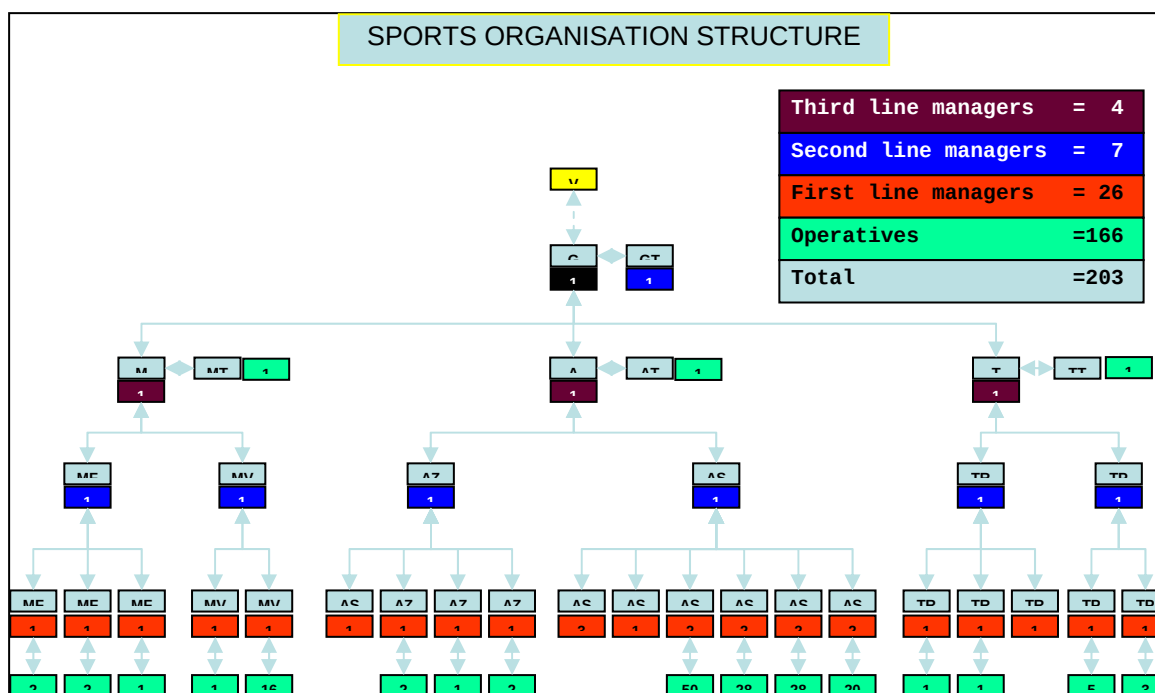


Figure 1. Classical hierarchical structure of sports organisation

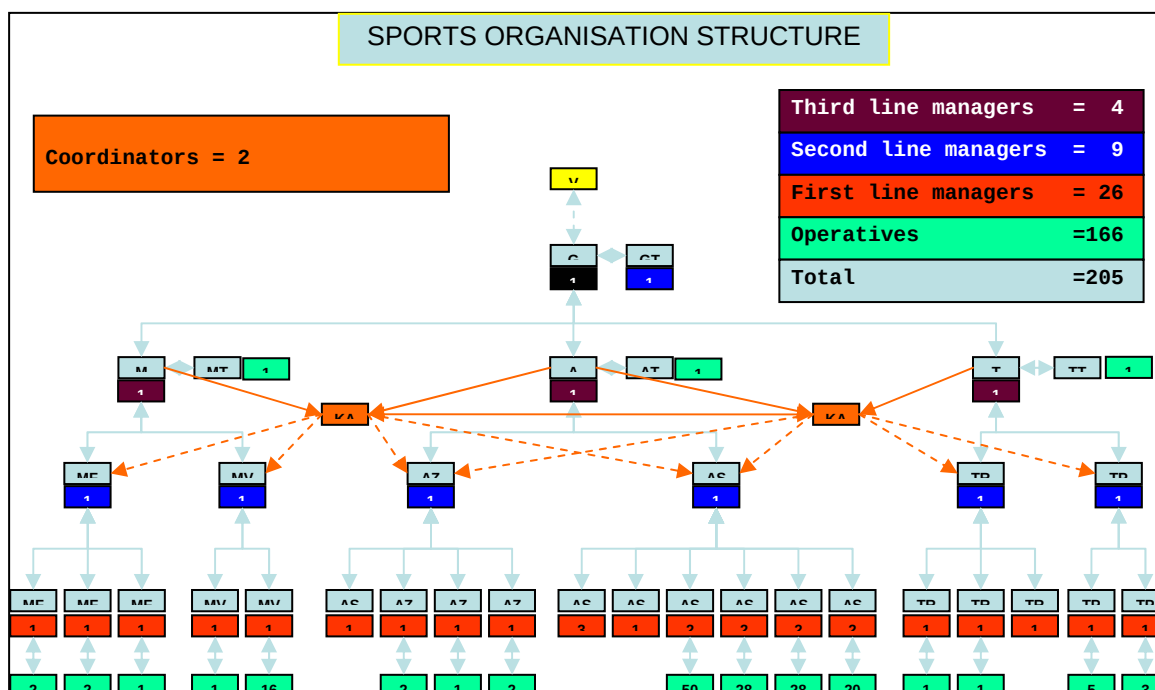


Figure 2. Modern structure of sports organisation

After the basic statistics, and taking into account the initial number of entities  $n=205$  which is existent in a model, the lesser number of types is methodologically searched: a) based on their grouping in the area of the entity (individuals) and b) based on the projection in the space of the variables (relations). The typical protocol of the data

*taxonomisation* was followed in order to determine the structure of relations in the space of the entity, the general types which realistically exist in such a structure, and where Uditax algorithm is chosen for the identification of the distinct taxons (so the entities belong to one and only one taxon), (Bonacin, 2004).

## Results and discussion

In a functioning organization a project is managed by using the existing organizational structure based on the division of labor and the specialization for similar jobs for which hierarchical organizational units are formed (Yin & Khoo, 2007). The responsibilities of project management are given to individuals from according functionally organized units (marketing, engineering, production, finances...), according to their fields of expertise, with the coordination of project leaders (<http://vets.athost.net>), who even though they have a permanent position in the organization, for the time being performs the role of the project coordinator. So, occasionally there is a need for a project manager inside the structure. Model from this project is formed in a way that the hypothetical sports organization is a system integrated with all its sub-systems, for if the sub-systems are outside the structure, its functionality is questionable, and so is its efficiency and success. Otherwise high structure like the governments, multinational companies or NATO would be decentralized and disintegrated. Under the assumption that an organization must be an integrated system, a classical sports organization model is formed.

The individuals inside the organization are given adequate roles, they were described with arbitrary and relevant variables which were considered to be interesting providers of information (Bonacin Da., 2008). The results of the data processing have shown the following; on the basis of grouping inside the space of an entity, in other words the transformation of data with the Uditax model (model of distinct taxons with each individual belonging to one and only one taxon), we got 6 relatively balanced taxons. It is noticeable that the first taxon gathers 47(22,39%) entities belonging to management and expert level, the second taxon gathers 50(24.39%) entities belonging to the pioneers, the third taxon gathers 28(13.66%) entities belonging to the kadettes, the fourth taxon gathers 28(13.66%)-juniors, the fifth taxon gathers 20 (9.76%)-seniors, and the sixth taxon gathers 32(15.61%) entities-technical support. After a detailed insight into the data, we can determine three superior types, three global mechanisms of structuring: 1. Management of all levels (logistics), 2. Operational support (technicians) and 3. The immediate product (players).

What is inherent to the results of the taxonomic analysis is the existence of only three types of elements of the higher structure: logistics, support and sport sector. But most of all the results clearly show the importance of management. Managerial positions inside the organization are identified through the process of creating the organizational structure. Building of that structure projects new job openings and organizational units, and the power is given to individual positions in relation to groups on all levels and in different stages of business process. The criterion of the organizational level and of the area of business is needed for the identification of the different parts of managers (Šunje, 2002), and project managers accordingly. It is clear from the results that the project managers are now an integral part of the management and share its destiny.

## Conclusion

In the existing classic model coordinators are introduced on a medium level (project managers), whose controlling function does not have a permanent character, and is only shown in the peculiar short-term situations (building of the sports centre, or selling two players for a big profit; anything that does not require the complete board, but a project team of a limited size and limited goals), it is an occasional occurrence. Project managers and the relations they manage are introduced for three reasons: a) a certain flexibility is needed, b) to harmonize the functions of the different sectors, but not the top of the commanding chain, but the inter-sector transfer of the parts of authority when the situation allows, and c) time component is relevant-it is needed only from time to time (Chart 4). With the introduction of the project managers the system gained flexibility and the rigidity of the system is reduced both internally and externally. It is obvious that this model has a part of mechanical and a part of organic organization. The position of the coordinator (project manager) is not decisive for the functioning of the sports organization, it is more a series of temporary tasks which do not significantly change the essence or the actions. Based on the postulates, it is a fact that they make the organization slightly more flexible, but as they are part of the logistics, their role is generally marked with that dominant position in the management. And nothing more.

Table 1. Position of particular entities on isolated taxons

|                                  | TX1  | TX2  | TX6  | TX3  | TX5  | TX4  |
|----------------------------------|------|------|------|------|------|------|
|                                  | 47   | 50   | 28   | 28   | 20   | 32   |
| Top manager                      | 3.93 |      |      |      |      |      |
| Business secretary               | 1.72 |      |      |      |      |      |
| Inter-sector coordinator KAM     | 2.34 |      |      |      |      |      |
| Inter-sector coordinator KAT     | 2.28 |      |      |      |      |      |
| Manager of antropological status | 3.00 |      |      |      |      |      |
| Secretary                        |      |      |      |      |      | 1.70 |
| Sports manager                   | 2.62 |      |      |      |      |      |
| Tactical coach                   | 1.10 |      |      |      |      |      |
| Informatician                    | 1.08 |      |      |      |      |      |
| Scaut                            | 1.87 |      |      |      |      |      |
| Coach of primar selection        | 1.23 |      |      |      |      |      |
| Coach of sport school A, B (2)   | 1.12 |      |      |      |      |      |
| Player begginer A (25)           |      | 1.26 |      |      |      |      |
| Player begginer B (25)           |      | 1.26 |      |      |      |      |
| Coach of cadets A, B (2)         | 1.18 |      |      |      |      |      |
| Cadet A (14)                     |      |      | 1.03 |      |      |      |
| Cadet B (14)                     |      |      | 1.03 |      |      |      |
| Coach of juniors A, B (2)        | 1.30 |      |      |      |      |      |
| Junior A (14)                    |      |      |      | 1.44 |      |      |
| Junior B (14)                    |      |      |      | 1.44 |      |      |
| Coach of seniors A, B            | 1.84 |      |      |      |      |      |
| Senior A (10)                    |      |      |      |      | 2.09 |      |
| Senior B (10)                    |      |      |      |      | 2.09 |      |
| Health manager                   | 2.25 |      |      |      |      |      |
| Support kinesiologist            | 1.61 |      |      |      |      |      |
| Physician diagnostics            | 1.79 |      |      |      |      |      |
| Laborant                         |      |      |      |      |      | 2.01 |
| Medical assistant                |      |      |      |      |      | 1.92 |
| Psychologist                     | 1.56 |      |      |      |      |      |
| Sociologist                      | 1.37 |      |      |      |      |      |
| Physiotherapist                  | 0.93 |      |      |      |      |      |
| Kinesiterapist                   | 0.74 |      |      |      |      |      |
| Physiotherapist                  | 0.69 |      |      |      |      |      |
| Manager of marketing segment     | 2.74 |      |      |      |      |      |
| Secretary                        |      |      |      |      |      | 1.96 |
| Promotion manager                | 2.54 |      |      |      |      |      |
| Market analyst                   | 1.80 |      |      |      |      |      |
| Market communication             | 1.28 |      |      |      |      |      |
| Propagandist                     | 1.22 |      |      |      |      |      |
| Contacts with fund sources       | 1.31 |      |      |      |      |      |
| Trade-person                     |      |      |      |      |      | 0.97 |
| Sales-person                     |      |      |      |      |      | 1.56 |
| Outside communication            | 1.90 |      |      |      |      |      |
| Funs communication               | 1.43 |      |      |      |      |      |
| Public relations                 | 1.47 |      |      |      |      |      |
| Manifestations organiser         | 1.56 |      |      |      |      |      |
| Law manager                      | 1.30 |      |      |      |      |      |
| Lawyer                           | 0.69 |      |      |      |      |      |
| Lawyer (assistant)               |      |      |      |      |      | 1.30 |
| Lawyer (contracts assistant)     | 0.69 |      |      |      |      | 1.30 |
| Organiser                        | 1.66 |      |      |      |      |      |
| Manager for material resources   | 2.33 |      |      |      |      |      |
| Secretary                        |      |      |      |      |      | 1.96 |
| Financijski menadžer             | 1.35 |      |      |      |      |      |
| Sales                            | 1.33 |      |      |      |      |      |
| Finantial accauntant             |      |      |      |      |      | 2.13 |
| Finantial assistant              |      |      |      |      |      | 2.15 |
| Supply                           | 1.33 |      |      |      |      |      |
| Accauntant                       |      |      |      |      |      | 2.13 |
| Accauntant assistant             |      |      |      |      |      | 2.15 |
| Pay accauntant                   |      |      |      |      |      | 1.94 |
| Administrative                   |      |      |      |      |      | 2.19 |
| Manager for values               | 1.37 |      |      |      |      |      |
| Object chief                     | 0.96 |      |      |      |      |      |
| Requisiter                       |      |      |      |      |      | 2.05 |
| Maintenence engineer             | 1.68 |      |      |      |      |      |
| Electro-mechanic A, B (2)        |      |      |      |      |      | 1.90 |
| Carpenter                        |      |      |      |      |      | 1.93 |
| House keeper                     |      |      |      |      |      | 2.04 |
| Others                           |      |      |      |      |      | 2.03 |
| Security A, B (8)                |      |      |      |      |      | 1.85 |
| Cleaner A, B (3)                 |      |      |      |      |      | 2.22 |

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## POZICIJA PROJEKTNIH MENADŽERA U FUNKCIONALNO STRUKTURIRANOJ SPORTSKOJ ORGANIZACIJI

### Sažetak

Na temelju principa klasičnih teorija organizacije, spoznaja iz menadžmenta, teorije sporta te općih teorija iz različitih područja, dizajniran je virtualni sportski klub, na način da posjeduje sve pripadajuće funkcije i pojedinačne uloge koje su potrebne radi ostvarenja sportskog rezultata i profita. Prema osnovnoj zamisli, funkcija je odredila strukturu a s obzirom da su karakteristike funkcionalno strukturirane sportske organizacije: visoka specijalizacija, stroga departmanizacija, jasan lanac komandi, uzak raspon kontrole, centralizacija i visoka formalizacija što je kao rezultat dalo krutost i nefleksibilnost iste, kako bi dobili na mekoći i fleksibilnosti u djelovanju unutar međusektorskog prijenosa dijela ovlasti, te zbog vremenske komponente – povremenosti, uvedena su dva projekt menadžera a cilj ovog rada je definicija njihove pozicije u ovako strukturiranoj organizaciji. Nadalje, svim pojedincima unutar strukture dodijeljen je individualni funkcionalni status s ciljem da se pokriju sve potrebne funkcije čime su se definisale sve individualne uloge. Ukupni broj tako dobivenih entiteta je 205 a broj korištenih varijabli globalnog karaktera je 40. Izvršena je taksonomizacija podataka Uditax modelom za identifikaciju distinktnih taksona. Rezultati su pokazali kako u prostoru entiteta postoji šest taksona te ono što je svojstveno rezultatima taksonomske analize je postojanje samo tri tipa elemenata više strukture a to su logistika (upravljanje), potpora (održavanje) i sportski pogon (proizvod). Rezultati su pokazali kako uvođenje projektnih menadžera u strukturu organizacije nije bilo presudno za funkcionisanje sportske organizacije. Ona je time malo dobila na mekoći odnosno u pozitivnoj mjeri je uklonjena rigidnost hijerarhije interno i eksterno ali projektni menadžeri egzistiraju kao sastavni dio logistike.

**Ključne riječi:** organizacija, struktura, projekt menadžeri, pozicija

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## HAPKIDO - 16 CONTINUOUS TECHNIQUES FOR OVERPOWERING THE OPPONENT

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### **Abstract**

*Article explains basic principles of Hapkido martial art.*

**Key words:** *Hapkido, principles*

### **Introduction (history)**

Modern Hapkido was founded thanks to the master Choi Yong Sool who was born in 1904. in Taegu. During Japanese occupation of Korea (1901.-1945.) as a young boy Choi Yong Sool was sent to Japan as a servant to Japanese officer Sogaku Takeda. Serving in Takeda's household, young Sool was able to observe daily exercises done by master Takeda and his son, and he started repeating seen moves in secrecy because at that period Koreans were forbidden from training martial arts. However, Takeda whose ancestors belonged to Minamoto clan, soon noticed that little Korean boy was observing him, and at first he punished the boy because he did not want to get into trouble with Japanese authorities over that.



After some time, Choi took Japanese name Tatujutu Yoshida, and was adopted by master Takeda who started teaching him the art of Daito Ryu Aiki Yu Yutsu, ancient samurai art that later evolved into Aikido. In 1945. Master Choi returned to his homeland Korea.

As story goes, one day the owner of local Taegu brewery, Suh Bok Sub witnessed how master Choi Yong Sool successfully defended himself from attackers. Being an owner of black belt in Judo himself, Suh recognized genuine skill in master Choi's movements and asked him to teach him that skill. Persuaded by Suh Bok Sub in 1951 Master Choi opened his school where he taught his fight style Hap Ki Yu Kwon Bop.



Among the other students of the school, in 1953. there was Ji Han Jae who himself was a master of tae kyon. By training hard under master Choi, master Ji noticed certain shortcomings of this art, and together with Kim Moo Wong, he added foot kicks and hand strikes taken from taekyon (predecessor of taekwondo), and named this art as it is known today HAPKIDO. Due to the fact that in the old script signs for Hapkido were identical to Japanese for Aikido, the art changed its name into Kido, but the old name was already widespread through the entire Korea so it was eventually changed back into Hapkido. Master Jin offered the name Hapkido to his master Choi Yong Sool as a token of respect for his skill, but Choi Yong Sool refused it. Master Choi's school gradually declined due to his age, so towards the end of

his life he went to the school of one of his former students where he named his mildly modified style. Chin Chun Kwan. This style disappeared following his death, except in just few Korean schools. Ji Han Jae founded Korea Hapkido Association and World Hapkido Federation.

After the change of political regime in Southern Korea, Master Ji was sent to prison because of his political involvement with former regime. He spent 6 years in prison. He was a personal bodyguard of the president in the overthrown regime. At that time, many of his students wanted to take over the governing of Federation, but they all failed. As it was not "prudent" to be associated with master Ji Han Jae at that time, their only way to take over the power in Hapkido was to form their own organizations of which are now more than 35. Only three of those were officially approved by Korean authorities, so their belts are recognized worldwide. Most of the mentioned 35 organizations are situated in the USA and are led by Korean students of Ji Han Jae, or by students of his students.

Regarding master Ji, upon serving his sentence he founded a new federation and a new Hapkido style called World Sin Moo Hapkido Federation. Sin Moo is Korean for Zen, and it was inspired by master's reflexions from six years long solitary confinement where he spent his time reading, learning and contemplating about Hapkido. His Federation is well spread in Korea, Europe, States and South America. In Korea there is also Korea Hapkido Federation which includes some of the organizations. Logo of that Federation is stylized fist with protruding thumb and index finger painted on red-blue Yin-Yang symbol.

Present Hapkido technique consists of the following:



- locks and jointlocks
- throwing
- grappling
- choking
- sweeping and pinning
- circular blocks
- hand strikes and kicks
- blocks
- applying pressure on pain points and pinching
- falling
- techniques using traditional weapons
- meditation and breathing

Master Choi died in 1986. And was buried in Taegu, on the other hand master Ji Han Jae currently lives and works in New Jersey, where he settled after fleeing from South Korea. Even though he is 65, he successfully organizes seminars all over the world.

### **What is Hapkido**



Hapkido is modern Korean martial art dating from mid 20<sup>th</sup> century. Founder of the modern Hapkido is Korean master Choi Yong Sool. Direct translation of the name from Korean language means "the way of coordinated power". Hapkido is a way to physical and mental coordination. Each movement requires total body coordination, and regular exercise in order to preserve that coordination. During 1940s Choi Yong Sool returned from Japan, where he (by some intricate coincidences) was practicing Japanese martial art called vjestiu Daito Ryu Aiki Ju Jutsu. Upon return to Korea, he invented his own martial art system named HAP KI DO. At that time, Hapkido was very similar to today's aikido. During '50s one of the students of old master Choi Yong Sool, Ji Han Jae who trained Korean art called tae kyon before he studied Hapkido, introduced blocking, hand strikes and foot kicks to hapkido thus making it the most complex of arts.



Every type mentioned is divided into offensive and defensive techniques. Techniques are used in different situations – standing, sitting, jumping, lying down, etc.

Combination of mentioned techniques makes comprehensive system of self-defence in any given situation. Practicing hapkido offers more than just ability to defend oneself. There are many advantages of training hapkido. The most important one is probably the good health achieved through regular training and exercise, discipline and concentration needed during the training for learning the techniques as much as it is needed in everyday life. Apart from this type of training there is also a competitive form of training.

There are still no competitions organized in Bosnia and Herzegovina, but there is every intention to organize those events. Entire art of hapkido is based on circular motions, and central body axis. All motions are natural, and follow the natural laws of physics and biomechanics. Koreans identify those motions to those of water; smooth as river flow, and destructive as wave. In all techniques, relation between Um and Yong (Yin and Yang) is present, soft and hard. UM represents soft, circular motions; and YONG represents hard, linear movements. Circular movements are employed during falls, locks, throwing, sweeping; linear movements are used for blocks, hand strikes and kicks.

Description of the techniques can be compared to some other arts, so the locks and jointlocks are very similar to those found in aikido; kicks, hand strikes and blocks are similar to taekwondo techniques; throwing techniques are similar to judo throws; grappling and pinning to those from jiu jitsu. Everything mentioned makes hapkido the most efficient system of training. Very important form of the training is mental training, as well as internal form of training like breathing. In this way a person is able to maximally use his internal energy or power called Ki or Chi in the East. Those exercises are called “Dan Jom”, and meditation is called “Muk sang ha da”. Apart from these values, hapkido develops ethical qualities of the practitioner through nine laws governing behavior and life as a part of Hapkido training.

By following these rules, introduced by Choi Yong Sool, we become conscientious and responsible members of the modern society.

At the same time, this type of training introduces us to the science of martial arts instead of just superficial training as it is the case with training of other martial sports. Hapkido trainees are dressed in dobok (kimono) similar to karate kimono.

- **humanity**
- **politeness**
- **trust and friendship**
- **goodness (generosity)**
- **loyalty**
- **honour**
- **knowledge**
- **courage**
- **common sense**



Colour of kimono depends on trainee's level and federation he/she belongs to because each federation has distinctive colour and shape of kimono. Level of trainee is marked by coloured belts in the same order as in taekwondo, but some federations have purple and brown belt as a part of their ranking. Highest master level is 9.Dan, while founders of federations are bestowed a 10. Dan. There are over 35 Hapkido Federations worldwide, as well as other organizations. Most of them are private organizations that sprang from zealous desire of Korean masters to be recognized as the main founders and presidents of the Federations. However, Korean government officially recognizes just few of them, and organizations themselves do not recognize their rivals.

The most famous are Korea Hapkido Federation, World Kido Federation, World Hapkido Association, International Hapkido Federation (Hankido), World Hapkido Federation and World Sin Moo Hapkido Federation. Some of those Federations are situated in the States because hapkido became very popular during Korean War when American soldiers, apart from fighting the war, trained many Korean martial arts including Hapkido.

## Hapkido principles

Hapkido utilizes circular, continuous, flowing motions with transitions from one to other techniques without any interruptions. By deflecting the attack with circular blocks and counterattacking, the entire fight change from

angle to angle by just revolving around the axis of the body. This allows transition from one circular motion to other. Exactly this is the concept on which Hapkido-“the way of coordinated power” was founded.

**YU**-Soft. Non- resistance, confronting the opponent utilizing the minimum of power avoiding direct confrontation with opponent's attack.

**WON**-Circle. Blocking and redirecting of opponents momentum, followed by counterattack by circular motions.

**HWA**-Water. Deflecting opponent's attack by flowing movements of the body, much like those of water flow.

## TRAINING PROGRAMME

### UPPER WHITE BELT (9. Geup)

- 1) 1. Breathing technique (il dan –jom)
- 2) hapkido falls: - frontal fall - backward fall - lateral fall
- 3) stands: - natural stand - straddling stand - long stand
- 4) blocks: - upper block - middle block - lower block
- 5) hand strikes : - direct hand strike
- 6) foot kicks: - frontal foot kick - frontal foot block
- 7) obligatory self-defence techniques:
  - first six techniques of approaching the opponent
- 8) theoretical classes: - rule of central axis - rule of the circle- rule of the water

### YELLOW BELT (8. Geup)

- 1) 2. Breathing technique (i dan-jom)
- 2) Meditation positions
- 3) hapkido falls : - frontal somersault fall - backward somersault fall - lateral somersault fall
- 4) stands: - short stand - walking stand - catlike stand - fight stand
- 5) blocks: - hammer block - block with the karate chop - guard block - guard block with karate chop
- 6) hand strikes: - direct hand strike (opposite leg forward) - wrist strike - fist strike from below (uppercut) - circular hand strike
- 7) foot kicks: - lateral kick - circular kick - cutting kick
- 8) self-defence techniques: - other six techniques of approaching the opponent

- 9) theoretical classes: - short history of hapkido - counting to 20 in Korean

### UPPER YELLOW BELT (7. Geup)

- 1) 3. Breathing technique (sam dan-jom)
- 2) techniques of meditation and relaxation
- 3) hapkido falls: - semi-somersault fall - frontal somersault fall with double strike - handstand – fall
- 4) stands: - akimbo stand – (movement stand) - deep straddling stand - crane stand
- 5) blocks: - x block with forearms - hammer block with open palm edge - double block with forearms
- 6) hand strikes: - hammer hand strike - strike with inner palm edge - finger prod (spear strike)
- 7) foot kicks: - ultimate kick - ultimate lateral kick - ultimate circular kick
- 8) self-defence techniques: - five self-defence techniques for frontal grappling - five self-defence techniques for back grappling - 2 self-defence techniques for knife attacks - 2 self-defence techniques for baton attacks
- 9) theoretical classes: - names of the techniques employed in upper white and yellow belt in Korean

### GREEN BELT (6. Geup)

- 1) 4. Breathing technique (sa dan-jom)
- 2) hapkido falls: - somersault fall - frontal somersault upwards over obstacles - frontal somersault forward over obstacles
- 3) blocks: - suppressing block - external hook block - internal hook block - block with "active" arm - double block with "active" arm
- 4) hand strikes: - double "hook" strike with thumbs - prodding with two fingers - "tiger

paw" - strike with the palm edge, from up to down - strike with palm's base - lateral elbow  
 5) foot kicks: - reverse foot kick - pressing frontal kick - stamping kick - reverse tamping kick - lateral foot block - "seal" heel kick - frontal air kick - lateral air kick  
 6) throwing techniques: - 4 hand - 2 foot throw  
 7) elbowlocks: - four directions of locks on wrist - elbowlock - shoulder lock  
 8) self-defence: - 10 self-defences from wrist grappling - 5 self-defences from hair grappling - 5 self-defences from choking - self-defences from knife: up-down stabbing, at sides from the outside, at sides from the inside - 3 self-defences from baton attack  
 9) theoretical classes: - names of the techniques employed in upper yellow and green belt in Korean

#### UPPER GREEN BELT (5. Geup)

1) blocks: - circular hand block - block with open back of the hand - block with upside down palm - block with inner foot edge - block with outer foot edge  
 2) hand strikes - frontal elbow strike - back elbow strike - circular elbow strike - prod with one finger - prod with thumb  
 3) foot kicks - circular roundhouse kick - double circular kick with the same foot - double circular kick - circular kick while landing - knee kick forward - lateral knee kick - knee kick downwards - circular air kick - back air kick  
 4) throwing techniques - 4 hand throws - 2 foot throws  
 5) locks - 2 elbowlocks - 2 shoulder locks  
 6) choking - 2 forearm - 2 palm  
 7) working with weapons - 2 techniques for short stick (dan-bong) - directions of knife cuttings - handling the knife  
 8) self-defence - 10 techniques of self-defence for lapel grappling - 5 techniques of self-defence for back grappling - 5 techniques of self-defence for shoulder holding - 5 techniques of self-defence for grappling with the opposite hand - 5 techniques of self-defence for knife attack - 2 techniques of self-defence for firearms attack  
 9) breaking techniques: - direct with fist - frontal foot kick  
 10) theoretical: - names of the techniques employed in upper green belt in Korean

#### BLUE BELT (4. Geup)

1) foot kicks: - back circular air kick - cutting air kick - frontal kick from the floor - lateral kick from the floor - back kick from the floor - back circular kick from the floor - circular kick from the floor

2) throwing techniques: - 4 hand throws - 4 foot throws - 2 self-sacrificing throws  
 3) locks: - 4 elbowlocks from sitting position - 4 shoulder locks from standing position  
 4) choking: - 4 cross choking - 2 doboko / kimono choking  
 5) working with weapons : - 2 techniques for short stick (dan-bong) - 2 techniques for knife attack  
 6) self-defence - 10 techniques of self-defence for elbow and forearm grappling - 10 techniques of self-defence for belt grappling - 5 techniques of self-defence for grappling with the opposite hand - 5 techniques of self-defence for knife attack - 4 techniques of self-defence for firearms attack - 5 techniques of self-defence for throwing  
 7) breaking techniques: - strike with the edge of the palm - lateral foot kick - one technique per examiner's choice  
 8) sparing 3x1 minutes  
 9) theoretical classes: - names of the techniques employed in blue belt in Korean

#### UPPER BLUE BELT (3. Geup)

1) foot kicks: - back air kick with revolving for 360° - back circular air kick - back circular air kick with revolving for 360° - double frontal air kick - frontal air kick with both legs - lateral air kick with both legs  
 2) throwing: - 4 hand throws - 4 foot throws - 4 self-sacrificing throws  
 3) locks: - 5 elbowlocks - 5 shoulder locks  
 4) choking: - 4 doboko / kimono choking  
 5) working with weapons - 2 techniques for short stick (dan-bong) - 2 techniques for knife attack  
 6) self-defence - 10 techniques of self-defence for hand strikes - 10 techniques of self-defence for foot kicks - 5 techniques of self-defence for holding with both hands - 5 techniques of self-defence for pushing - 5 techniques of self-defence for tie - 10 techniques of self-defence for weapons  
 7) breaking techniques: - wrist strike - circular foot kick - cutting foot kick - frontal air kick  
 8) sparing 3x 2 min.  
 9) theoretical classes: - names of the techniques employed in upper blue belt in Korean - principles of warming up and workout

#### RED BELT (2. Geup)

1) throwing: - 4 foot throws  
 2) locks : - 4 locks on the ground  
 3) choking: - 8 choking on the ground  
 4) working with weapons - 10 techniques for short stick (dan - bong) - 5 techniques for

knife attack- 2 techniques for walking sticks

5) self-defence : - 10 techniques of self-defence for frontal grappling - 10 techniques of self-defence for grappling with both hands - 15 techniques of self-defence for different weapons

6) sparing: - 3 x 2 min. - ground fight

7) breaking techniques: - strike with the inner side of the palm - elbow strike - back foot kick - lateral air kick, over the obstacle - one technique per instructor's choice

8) theoretical classes: - names of the techniques employed in red belt in Korean - ways and principles of leading the training

#### **BLACK BELT 1. DAN**

1) COMPLETE PROGRAM LEADING TO BLACK BELT

2) working with weapons: - 10 techniques for walking sticks - 20 techniques for short stick (dan-bong) - 15 techniques for knife attack - 5 techniques for middle length stick

3) self-defence: - 5 techniques of self-defence for wrist grappling - 5 techniques of self-defence for opposite hand grappling - 5 techniques of self-defence for hair grappling - 5 techniques of self-defence for shoulder grappling - 5 techniques of self-defence for lapel grappling - 5 techniques of self-defence for belt grappling - 5 techniques of self-defence for frontal grappling - 5 techniques of self-defence for back grappling - 5 techniques of self-defence for both hands grappling - 5 techniques of self-defence for hand strikes - 5 techniques of self-defence for foot kicks - 10 techniques of self-defence for knife attacks - 5 techniques of self-defence for baton attacks - 5 techniques of self-defence for firearm attacks

4) sparing: - 3 x 1 min. - ground fight - sparing against two opponents

5) breaking techniques: - 1 hand strike as per candidate choice - 1 foot kick as per candidate choice - 1 air foot kick as per candidate choice - 1 special technique as per candidate choice - 1 technique as per examiner's choice

6) theoretical classes: - history of hapkido - philosophy of hapkido - name of certain techniques in Korean

#### **16 different defences from the attacker**

1. Attacker and person attacked are in a normal, moderately astride stand. Attacker grabs the attacked person's wrist. Using the right hand, attacker grabs the attacked person's left hand. Attacked person maximally spreads the fingers thus weakening attacker's squeeze.

After that the attacked person moves into so called straddling stand thus entering the opponent's "interior" which results in liberation of his hand. After that, using freed hand person attacked employs his elbow to strike the attacker in the plexus region. As a result, the opponent is overpowered in a single step.

2. Attacker and person attacked are in a normal, moderately astride stand. Attacker grabs the attacked person's wrist. Using the right hand, attacker grabs the attacked person's left hand. Attacked person maximally spreads the fingers thus weakening attacker's squeeze. After that the attacked person moves into so called straddling stand thus entering the opponent's "interior" in one long forward stand resulting in upper body leaning towards the opponent's body. Using the external part of the freed hand. i.e. using the palm edge attacked person strikes the opponent to the neck and the opponent is down.

3. Attacker and person attacked are in a normal, moderately astride stand. Attacker grabs the attacked person's wrist. Using the right hand, attacker grabs the attacked person's left hand. Attacked person maximally spreads the fingers thus weakening attacker's squeeze. After that the attacked person moves into so called straddling stand thus entering the opponent's "interior" in one long forward stand resulting in upper body leaning towards the opponent's body. Using the upper, external part of the closed freed hand attacked person strikes the opponent to the temple region thus effectively rendering him disabled.

4. Attacker and person attacked are in a normal, moderately astride stand. Attacker grabs the attacked person's wrist. Attacked person moves into mildly forward stand and strikes the opponent's wrist area (i.e. lower part of the forearm) using the freed hand. After that, the attacked person moves into so called catlike stand i.e. turns his back to the opponent and using the freed arm strikes the opponent to the stomach area.

5. Attacker and person attacked are in a normal, moderately astride stand. Attacker grabs the attacked person's wrist. Attacked person over-grabs the hand i.e. utilizes the grabbed arm to grab the opponent's arm in turn. After that the attacked person moves into so called "straddling" stand and pulls the opponent's attacking hand utilizing his own freed hand, attacked person then strikes the opponent's rib cage area (using elbow).

6. Attacker and person attacked are in a normal, moderately astride stand. Attacker grabs the attacked person's wrist. Attacked person over-grabs the hand i.e. utilizes the grabbed arm to grab the opponent's arm in turn. After that the attacked person moves into so called "straddling" stand and using his freed arm strikes the opponent's forearm with so called cutting strike i.e. utilizing the edge of the palm to deliver the strike in downward direction to the opponent's biceps area thus freeing himself from attacker's arm and moving into long forward stand resulting in delivering the blow using the open hand edge to the opponent's neck. Opponent is then successfully overpowered and is down.

7. Attacker and person attacked are in a normal, moderately astride stand. Attacker grabs the attacked person's wrist. Attacked person then makes the sudden hand move downwards, maximally spreading the fingers of the attacked hand in order to decrease the opponent's squeeze. Next step involves over-grabbing with both hands on attacker's hand. Attacked person then moves into "straddling" stand, enters the opponents "interior" pressing elbow to elbow. At the same time, making the lock on attacker's arm. Opponent is disabled and submitted.

8. Attacker and person attacked are in a normal, moderately astride stand. Attacker grabs the attacked person's wrist. Attacked person then makes the sudden hand move downwards, maximally spreading the fingers of the attacked hand in order to decrease the opponent's squeeze. Next step involves over-grabbing with both hands on attacker's hand and twists it. Thus opponent's hand is in a lock and rendered incapable.

9. Attacker and person attacked are in a normal, moderately astride stand. Attacker grabs the attacked person's lower part of the forearm, while the attacked person is defending himself using the same grab. At the same time, attacked person moves under opponent's arm and folds it under opponent's armpit thus making the lock on opponent's fingers. After that the attacked person straightens the opponent's hand holding him in a lock utilizing the other arm to apply the pressure to opponent's triceps. Upon that, the attacked person moves into long forward stand and pushes the opponent's arm making him do the somersault fall. While doing that, the attacker never lets go of the opponent's arm which then ends in ground lock – pressing the opponent's elbow to his knee thus placing the opponent into submitted position.

10. Attacker and person attacked are in a normal, moderately astride stand. Attacker grabs the attacked person's lower part of the forearm, while the attacked person is defending himself using the same grab on opponent's attacking hand while placing his own hands to the chest utilizing the elbow of the attacked hand to make the lock on opponent's arm. Then he moves the opponent's arm maximally upwards and then revolves for 180 °. Upon turning like this, attacked person places his own elbow between opponent's shoulder blades and using the large forward stand pulls the opponent backward forcing him to the floor.

11. Attacker and person attacked are in a normal, moderately astride stand. Attacker grabs the attacked person's lower part of the forearm, while the attacked person is defending himself using the same grab on opponent's attacking hand while placing his own hands to the chest utilizing his free arm to lock the opponent's wrist. After that the attacked person places his free arm onto opponent's elbow thus effectively executing so called triceps cutting, while at the same time moves forward and renders the opponent subdued.

12. Attacker and person attacked are in a normal, moderately astride stand. Attacker grabs the attacked person's lower part of the forearm, while the attacked person is defending himself by grabbing the attacker's wrist and twisting his arm thus making a lock on the opponent's ulna. The attacked person then places both hands to his chest and makes the downward pressure. After employing this downward pressure, person can utilize either forward stand or backward. This move puts the opponent in a bad position.

13. Attacker and person attacked are in a normal, moderately astride stand. Attacker grabs the attacked person's clothes in the shoulders area. Attacked person pretends to be attempting the escape to the opposite side in order to maximally stretch the opponent's arm. Then from the inside, places his attacked hand onto opponent's hand rendering the opponent's elbow in a lock. Then, the attacked person strikes the opponent's face with an open hand, in order to dazzle him a bit. Attacked person then places his free hand onto opponent's arm, then this attacked arm presses onto his own arm in the region of forearm thus locking the entire opponent's arm rendering him helpless in the process. By executing small, forward stand person then throws the opponent down without

letting him go. Attacked person then uses his knee to press the opponent's ribs, locking his elbow at the same time. Thus the opponent is overpowered.

14. Attacker and person attacked are in a normal, moderately astride stand. Attacker frontally grabs the attacked person's hair. Attacked person defends itself using both hands, grabs the opponent's wrist and kicks him in the genital region. This makes the attacker to move his hands from the attacked person. Then the attacked person moves to grab the opponent's hands and locks his fingers.

15. Attacker and person attacked are in a normal, moderately astride stand. Attacker grabs the attacked person's chest with both hands. Attacked person defends himself by delivering a sudden strike to opponent's face or genital region in order to distract him from

the grab. After this surprise blow, the attacked person moves to make the lock on one of opponent's arms by grabbing his hand, twisting it while pressing the opponent's elbow at the same time. Thus the opponent is overpowered.

16. Attacker and person attacked are in a normal, moderately astride stand. Attacker grabs the attacked person's chest with one hand. Attacked person defends himself by delivering a sudden strike to opponent's face or genital region in order to distract him from the grab. After this surprise blow, the attacked person moves to make the lock on one of opponent's arms by grabbing his hand, delivering sudden downwards pressure with simultaneous stepping forwards or backwards. This move puts the opponent in a bad position.

### Conclusion

As a conclusion we can just say that Hapkido, as a martial art, is very useful. As such it can be employed in all dangerous situations as well as in everyday life.

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## HAPKIDO - 16 KONTINUIRANIH TEHNIKA ZA SAVLADAVANJE PROTIVNIKA

### Sažetak

Članak objašnjava temeljne principe Hapkido borilačke vještine.

**Key words:** Hapkido, principi

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## THE QUANTITATIVE CHANGES OF STUDENTS' MOTOR ABILITIES PRODUCED BY A 12-WEEK COMBINED FITNESS PROGRAM

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Original scientific paper

### Abstract

*The aim of the study was to find out partial quantitative changes of students' motor abilities, produced by applied 12-week combined fitness program. All participants were health sport faculty male students with ages  $19 \pm 1$ . The experimental program included a three times work out per week, two times resistance, weight training and once a week plyometric training. In order to detect potential changes we conducted paired sample t-test. The obtained results showed that the program has made statistically significant changes on 14 of 18 tests. The highest level of transformation has made on variables for static and repetitive strength assessment. The improvement was between 18 and 55 percent. Also, less, but no less significant changes have been produced on explosive power, flexibility and segmental speed tests. We think, that fine adjusted training load to all participants, respectively, an individualised approach, contributed to exceptional results. Our opinion is that this kind of fitness program should be part of regular faculty program during all educational period, in order to enhance students' motor capacities and make their way to the finish line easier.*

**Key words:** fitness program, motor abilities, changes, paired sample t-test

### Introduction

Motor abilities are inseparable part of every person. The level of motor ability's development, capacity and heredity are something that discriminate one person from other. A permanent interest of kinesiology researchers is how to produce their, in an optimum way, positive transformations, respectively, to make the biggest possible effects in the shortest time. It is known that an exercise is a stress that body needs to deal with. Only if the next stressor is more intense than previous one, we can expect that cumulative effects of training will occur. Therefore, it is not hard to conclude that just an appropriate choice of kinesiology operators, adjusted to every person, can create wanted effects. Long-term adaptation to the stress (an exercise), that actually happens between two training sessions, is the main goal of every programmed physical activity. A body is led out from state of homeostasis in order to make him more resistible to an external load i.e. faster, stronger, and more enduring than it was before some fitness program was applied. An examination of different kind of fitness programs, loads, exercise's volume and intensity, rest intervals, training methods are some of field of interests when we talk about exercising and its effects on anthropological status of person.

These kinds of researches have produced a conception of different fitness programs and methods for motor abilities improvement, as various resistance and weight training, vibration training, electro stimulation, proprioception training, plyometrics training, interval and fartlek training etc. This research concerns effects of combine fitness training, which consists of two trainings; a weight training and plyometrics, on eighteen motor tests that cover six hypothetically established motor dimensions. According to Fleck, S.J. and Kraemer, W.J. (2004), "high velocity plyometrics which consist of a rapid eccentric muscle action followed by a powerful concentric muscle action are important for enhancing the rate of force development during jumping and sprinting, whereas heavy resistance training is needed to enhance muscular strength and acceleration". Previous researches, conducted with similar goal and with more criterion variables, have been carried out by Avery D. F. at al. (2007), who compared effects of six weeks combine plyometrics and resistance training with resistance training alone. Although, both groups showed improvement in all tested variables, (vertical jump, long jump, medicine ball toss, 9.1 m sprint, pro agility shuttle run and flexibility), the plyometrics-resistance group demonstrated better results than resistance group alone.

These findings suggest that the addition of plyometric training to a resistance training program may be more beneficial than resistance training and static stretching for enhancing selected measures of upper and lower body power in boys. Other studies mostly compare effects of mentioned programs (combined plyometrics-resistance and resistance training alone) on vertical jump performance. Adams et al. (1992) evaluated efficacy of three different programs (squat training, plyometrics, and combination) on vertical jump height. The subjects who performed a combined training achieved a statistically greater improvement. The results indicate that both squat and plyometrics training are necessary for improving hip and thigh power production as measured by vertical jumping ability. Fatouros et al. (2000) reported that subjects who performed 12-week combined training program have achieved statistically the greatest enhancement in vertical jump ability. The other researches which results are going to be quoted in this paper, mainly dealt with effects of plyometrics training on explosive power of lower and upper limbs, and agility.

## Methods

### Participants

Thirty six actually healthy college male students with ages  $19 \pm 1$  year participated in this study. All participants chose subject Fitness as an optional course. All of them had shorter or longer history of physical activity participation, but during the study they were not included in any organised sport activity except those related with the research. Only participants who had hundred percent of training session attendance have been considered in the examination.

### Instruments

The sample of variables consisted of an 18-test battery of measuring instruments assessing motor abilities. The analyzed motor tests covered the following hypothetical motor abilities: segmental speed: (MBFTAP – an arm plate tapping, MBFTAN – a foot plate tapping, and MBFTAZ – a foot tapping on a wall), flexibility (MFLBOS – a side leg stretch, MFLISK – a twist with the stick, and MFLPRK – a sit and reach), explosive power: (MFESSVM – a vertical jump, MFETRO – a triple jump from standing position, and MFEBML – a medicine ball toss), repetitive strength:

(MRESKL – push ups, MREPTL – sit ups, and MRCZTL – a back extension), static strength (MSLIZP – a squat position maintenance, MSAVIS – a bent-arm hang, and MSCHIL – a horizontal maintenance) and agility and total body coordination: (MAGKUS – 4 meters shuffle steps, MAGTUP – a zig-zag test, and MAGOSS – a figure eight running). In following tables variables are written with letter “I” or “F” at the end of all variables’ acronyms. The letters represent initial and final testing session variables. The assessment was carried out in University sport hall in morning hours.

### Experimental program

The realised fitness program consisted of two programs combination; the weight training (two times a week) and plyometrics (once a week). The program was carried out in the first semester of school year and it lasted for twelve weeks. Before participants started with weight training, they had been tested by sixteen weight lifting exercises (bench press, squat, hang clean, leg press, step ups, leg extension, leg curl, leg adduction and abduction, back extension, sit ups, sitting military press, triceps press downs, lat pull-downs, barbell upright row, standing curl bar curls) in order to get their 1 RM - repetitium maximum (the maximal load a person can lift in one attempt). Based on 1-RM the exercises’ intensity has been determined for each participant. Prior the weight training subjects performed 15-minut warm up. The exercises’ intensity has increased linearly from week to week as participants get stronger. Because the subjects were beginners in weight training, first two weeks of the program were designed in order to prepare their musculoskeletal system for the following training and to learn proper techniques and principles of this kind of resistance training. The rest of program was created to enhance muscular endurance and hypertrophy, and, as the program was approaching to the end, participants had to deal with sub maximal and maximal exercise’s intensity which implicated maximal power enhancement. A number of series, repetitions and rest intervals were determined according to recommendations for beginners: “Training loads characterized by one to three series, with eight to twelve repetitions, intensities of 70 to 85% of 1MR and pauses between one and two minutes, correspond to the recommendations for muscular hypertrophy training with amateur/intermediate individuals”.

The second part of the program was related to plyometrics training. "Plyometrics refers to human movement that involves an eccentric muscle contraction immediately and rapidly followed by a concentric contraction. Plyometrics is a type of exercise training designed to produce fast, powerful movements (jumps, sprints, throws...), and improve the functions of the nervous system"<sup>(3)</sup>. Fifteen minutes warm up was standard procedure prior to plyometric exercises. In first two weeks subjects have met plyometrics training, its principles and safety consideration, and using low intensity exercises (skips, sprints, hops, double-leg jumps in place, running in place, skipping rope and side to side jumps over a small barrier) gradually reached more intense exercises, that included different depth jumps and medical balls toss. By means of different bench heights for drop jumps and different medical ball weights we successfully controlled the work out intensity. The types of exercises and its intensity was determined

according to the book "Jumping into plyometrics" (1998), written by Chu, D.A.

## Results

Using a paired sample t-test we tried to ensure if the 12-week combined fitness program had produced any partial quantitative effects on tested variables. Two testing sessions were carried out; an initial, before the start of the program, and the other, a final assessment, after the program realisation. Table 1 shows descriptive statistic for all variables. As it noticeable all final variables' values have been increased comparing them with their initial pairs, except time determined variables where lower value means better result. Pre-post standard deviation values reveal that participants had the highest variability in variables for static and explosive strength estimation, but the lowest variability in variables for segmental speed and agility evaluation.

Table 1. Paired samples statistics

| pairs  | variables | Mean   | N  | Std. Dev. | Std. Error Mean |
|--------|-----------|--------|----|-----------|-----------------|
| Pair 1 | MBFTAPI   | 40,53  | 36 | 1,99      | 0,332           |
|        | MBFTAPF   | 44,56  | 36 | 2,84      | 0,474           |
| Pair 2 | MBFTANI   | 43,28  | 36 | 4,58      | 0,764           |
|        | MBFTANF   | 44,75  | 36 | 3,24      | 0,54            |
| Pair 3 | MBFTAZI   | 24,97  | 36 | 2,99      | 0,498           |
|        | MBFTAZF   | 26,31  | 36 | 3,02      | 0,504           |
| Pair 4 | MFLBOSI   | 175,44 | 36 | 15,24     | 2,54            |
|        | MFLBOSF   | 179,86 | 36 | 13,00     | 2,167           |
| Pair 5 | MFLISKI   | 82,44  | 36 | 13,13     | 2,188           |
|        | MFLISKF   | 79,03  | 36 | 12,91     | 2,152           |
| Pair 6 | MFLPRKI   | 29,35  | 36 | 9,95      | 1,659           |
|        | MFLPRKF   | 31,33  | 36 | 9,23      | 1,539           |
| Pair 7 | MFESSVMI  | 49,78  | 36 | 6,25      | 1,041           |
|        | MFESSVM   | 54,92  | 36 | 7,33      | 1,222           |
| Pair 8 | MFETROI   | 687,5  | 36 | 54,00     | 9,001           |
|        | MFETROF   | 709,72 | 36 | 51,59     | 8,598           |
| Pair 9 | MFEBMLI   | 125,94 | 36 | 17,46     | 2,911           |
|        | MFEBMLF   | 134,47 | 36 | 15,12     | 2,519           |

Table 2 shows statistically significant correlation between every pre-post variable, excluding variable MBFTAPN, which shows enhancement, but it is not consistent across all subjects, i.e. several subjects improved their results, but several others did not.

| pairs   | variables | Mean  | N  | Std. Dev. | Std. Error Mean |
|---------|-----------|-------|----|-----------|-----------------|
| Pair 10 | MRESKLI   | 26,44 | 36 | 9,61      | 1,60            |
|         | MRESKLF   | 34,78 | 36 | 9,77      | 1,63            |
| Pair 11 | MREPTLI   | 17,56 | 36 | 7,48      | 1,25            |
|         | MREPTLF   | 23,83 | 36 | 7,39      | 1,23            |
| Pair 12 | MRCZTLI   | 36,08 | 36 | 13,50     | 2,25            |
|         | MRCZTLF   | 44,11 | 36 | 12,80     | 2,15            |
| Pair 13 | MSLIZPI   | 27,73 | 36 | 18,30     | 3,05            |
|         | MSLIZPF   | 61,8  | 36 | 39,80     | 6,64            |
| Pair 14 | MSAVISI   | 56,14 | 36 | 18,30     | 3,05            |
|         | MSAVIS    | 59,36 | 36 | 16,90     | 2,82            |
| Pair 15 | MSCHILI   | 24,94 | 36 | 11,60     | 1,93            |
|         | MSCHILF   | 32,34 | 36 | 14,90     | 2,49            |
| Pair 16 | MAGKUSI   | 8,55  | 36 | 1,19      | 0,20            |
|         | MAGKUSF   | 8,35  | 36 | 0,80      | 0,13            |
| Pair 17 | MAGTUPI   | 24,45 | 36 | 1,48      | 0,25            |
|         | MAGTUPF   | 24,32 | 36 | 1,31      | 0,22            |
| Pair 18 | MAGOSSI   | 17,64 | 36 | 1,45      | 0,24            |
|         | MAGOSSF   | 16,77 | 36 | 1,09      | 0,18            |

Table 3, - "Mean" illustrates average differences of pre-post variables, that is, the effects produced by the 12-week fitness program realisation. The biggest differences are evident with variables for static and dynamic muscular endurance, and with variable a triple jump from standing position.

The t-test values are statistically significant for fourteen of eighteen variables, that means, the produced effects can be attributed to the accomplished fitness program.

Table 2. Paired samples correlations

| pairs  | variable | Corr | Sig. |
|--------|----------|------|------|
| Pair 1 | MBFTAP   | ,577 | ,000 |
| Pair 2 | MBFTAN   | ,265 | ,119 |
| Pair 3 | MBFTAZ   | ,785 | ,000 |
| Pair 4 | MFLBOS   | ,899 | ,000 |
| Pair 5 | MFLISK   | ,785 | ,000 |
| Pair 6 | MFLPRK   | ,931 | ,000 |
| Pair 7 | MFESSV   | ,835 | ,000 |
| Pair 8 | MFETRO   | ,870 | ,000 |
| Pair 9 | MFEBML   | ,855 | ,000 |
| Pair   | MRESKL   | ,853 | ,000 |
| Pair   | MREPTL   | ,475 | ,003 |
| Pair   | MRCZTL   | ,673 | ,000 |
| Pair   | MSLIZP   | ,664 | ,000 |
| Pair   | MSAVIS   | ,802 | ,000 |
| Pair   | MSCHIL   | ,663 | ,000 |
| Pair   | MAGKUS   | ,541 | ,001 |
| Pair   | MAGTUP   | ,710 | ,000 |
| Pair   | MAGOSS   | ,580 | ,000 |

That was not a case with four variables, which t-test values are not statistically significant, although, there are some average differences between pre-post results, but they are not consistent across all subjects, i.e. several subjects improved their results, but several others did not. The produced outcome of these four variables cannot be attributed to the program.

Table 4 shows a percentage of the effects produced by the applied fitness program. The variables in the table are arranged according to percentage values; from the highest to the lowest. As it evident, the highest changes are made on variables for static and repetitive strength estimation. It was expected because the tested abilities are genetically very low determined. A static strength of lower limbs increased for 55%. Isometric and dynamic endurance of abdomen muscles enhanced for 25 and 26%. The repetitive strength of upper limbs and back muscles increased for 24 % and 18 %. As it obvious, results in other variables increased for 10% or less, whereas, there were not any statistically significant effects on variables (MBTAZ, MSAVIS, MAGKUS and MAGTUP).

Table 3. Paired sample test

| pairs   | variables           | Paired Differences |           |              |                                            |        | t      | df | Sig. (2-tailed) |
|---------|---------------------|--------------------|-----------|--------------|--------------------------------------------|--------|--------|----|-----------------|
|         |                     | Mean               | Std. Dev. | Std. E. Mean | 95 % Confidence Interval of the Difference |        |        |    |                 |
|         |                     |                    |           |              | Lower                                      | Upper  |        |    |                 |
| Pair 1  | MBFTAPI - MBFTAPF   | -4,03              | 2,35      | ,39          | -4,82                                      | -3,23  | -10,29 | 35 | ,000            |
| Pair 2  | MBFTANI - MBFTANF   | -1,47              | 4,86      | ,81          | -3,11                                      | ,17    | -1,81  | 35 | ,078            |
| Pair 3  | MBFTAZI - MBFTAZF   | -1,33              | 1,97      | ,33          | -2,00                                      | -,67   | -4,05  | 35 | ,000            |
| Pair 4  | MFLBOSI - MFLBOSF   | -4,42              | 6,72      | 1,11         | -6,68                                      | -2,14  | -3,94  | 35 | ,000            |
| Pair 5  | MFLISKI - MFLISKF   | 3,42               | 8,55      | 1,42         | ,53                                        | 6,30   | 2,39   | 35 | ,022            |
| Pair 6  | MFLPRKI - MFLPRKF   | -1,99              | 3,64      | ,61          | -3,21                                      | -,75   | -3,27  | 35 | ,002            |
| Pair 7  | MFESSVMI - MFESSVMF | -5,14              | 4,04      | ,67          | -6,50                                      | -3,77  | -7,63  | 35 | ,000            |
| Pair 8  | MFETROI - MFETROF   | -22,22             | 27,03     | 4,50         | -31,36                                     | -13,07 | -4,93  | 35 | ,000            |
| Pair 9  | MFEBMLI - MFEBMLF   | -8,52              | 9,06      | 1,51         | -11,59                                     | -5,46  | -5,64  | 35 | ,000            |
| Pair 10 | MRESKLI - MRESKLF   | -8,33              | 5,26      | ,88          | -10,11                                     | -6,55  | -9,50  | 35 | ,000            |
| Pair 11 | MREPTLI - MREPTLF   | -6,27              | 7,62      | 1,27         | -8,85                                      | -3,69  | -4,94  | 35 | ,000            |
| Pair 12 | MRCZTLI - MRCZTLF   | -8,02              | 10,69     | 1,78         | -11,64                                     | -4,41  | -4,50  | 35 | ,000            |
| Pair 13 | MSLIZPI - MSLIZPF   | -34,07             | 30,89     | 5,14         | -44,52                                     | -23,61 | -6,61  | 35 | ,000            |
| Pair 14 | MSAVISI - MSAVIS    | -3,21              | 11,16     | 1,86         | -6,99                                      | ,56    | -1,73  | 35 | ,093            |
| Pair 15 | MSCHILI - MSCHILF   | -7,40              | 11,32     | 1,88         | -11,23                                     | -3,57  | -3,92  | 35 | ,000            |
| Pair 16 | MAGKUSI - MAGKUSF   | ,20                | 1,02      | ,17          | -,14                                       | ,54    | 1,17   | 35 | ,246            |
| Pair 17 | MAGTUPI - MAGTUPF   | ,13                | 1,08      | ,18          | -,24                                       | ,49    | ,71    | 35 | ,480            |
| Pair 18 | MAGOSSI - MAGOSSF   | ,87                | 1,21      | ,20          | ,46                                        | 1,27   | 4,30   | 35 | ,000            |

Table 4. Percentage of the effects produced by the applied fitness program

| Number | VARIABLES                                   | Motor ability that is tested              | Percentage of produced effect |
|--------|---------------------------------------------|-------------------------------------------|-------------------------------|
| 1.     | MSLIZP – squat position maintenance         | static strength of lower limbs            | 55,00 %                       |
| 2.     | MREPTL – sit ups                            | repetitive strength of abdomen            | 26,32 %                       |
| 3.     | MSCHIL – horizontal position maintenance    | static strength of abdomen                | 25,00 %                       |
| 4.     | MRESKL – push ups                           | repetitive strength of arms and shoulders | 24,00 %                       |
| 5.     | MRCZTL – back extension                     | static strength of back                   | 18,21 %                       |
| 6.     | MFESSVM – vertical jump                     | Explosive power of lower limbs            | 9,36 %                        |
| 7.     | MBFTAP – arm plate tapping                  | Segmental speed                           | 9,00 %                        |
| 8.     | MFEBSL – medicine ball toss                 | Explosive power of upper limbs            | 6,35 %                        |
| 9.     | MFLPRK – sit and reach                      | Trunk flexibility                         | 6,33 %                        |
| 10.    | MBFTAZ – a foot tapping on a wall           | Segmental speed                           | 5,10 %                        |
| 11.    | MAGOSS – eight figure run                   | Agility                                   | 5,00 %                        |
| 12.    | MFLISK – twist with the stick               | Flexibility of arms and shoulders         | 4,14 %                        |
| 13.    | MFETRO – triple jump from standing position | Explosive power of lower limbs            | 3,14 %                        |
| 14.    | MFLBOS – a side leg stretch                 | Lower limbs flexibility                   | 1,35 %                        |

## Discussion

Observing the obtained results, it is obvious that realised program have produced the partial quantitative changes on fourteen of eighteen variables for motor abilities evaluation. The highest effects have been produced on variables for muscular static and dynamic endurance. The reasons for this we can find in the weight training design, especially, in its first part when the participants had to deal with smaller loads and big number of exercise's series and number of repetitions.

The program effects on explosive power tests (a vertical jump, a medicine ball toss and a triple jump from standing position) are smaller, but not less significant because explosive power is ability that is genetically high determined, i.e. it is very hard to make any transformation, so every change made on this ability is valuable. The combined program, especially plyometrics part, has produced the highest effects on a vertical component of jumping ability (9,3 %), than on the horizontal component and musculo-tendonos system reactivity (3,14%), and on explosive power of upper limbs ( 6,35 %). The effects' percentage produced on explosive power is compatible with results found by Fatouros and colleagues (2000). They reported that after 12 weeks of training, adult subjects, who combined plyometric training

with resistance training, increased vertical jump performance by 15%, whereas gains of 11% and 9% were reported for subjects who performed only resistance training or plyometric training, respectively. Other studies examine just effects of plyometric training. Marković (2007), based on data extracted from 26 different studies about the plyometric training effects on jumping ability, reported that “Plyometric training provides a statistically significant and practically relevant improvement in vertical jump height with the mean effect ranging from 4.7% (squat and drop jump), over 7.5% (countermovement jump – arms swing) to 8.7% (countermovement jump – free arms).

These results justify the application of plyometric training for the purpose of development of vertical jump performance in healthy individuals”.Matavulj et al. (2001) carried out two experimental plyometrics training for jumping performance improvement of young basketball players. The both groups improved their vertical jump height (4.8 i 5.6 cm) that is also compatible with our findings (5,14 cm; table 3). Vossen, J.F. et Al. (2000) compared “dynamic push up and plyometric push-up training programs on 2 criterion measures: a medicine ball toss and the maximum weight for 1 repetition of a sitting, 2-handed chest press.

The plyometrics group experienced significantly greater improvements than the other group on the medicine ball put, while there was no significant difference between groups for the chest press, although the plyometrics group experienced greater increases". It is possible that the program i.e. its plyometrics part could be designed with bigger number of depth jumps exercises, but because of safety considerations, and recommendations for training with amateur/intermediate individuals, it was not a case in our study. More intense plyometrics exercises can be involved in a training program of well experienced athletes and examined in some future research. Although, there is a stereotypic opinion that a weight training decrease flexibility, the study confirmed, once again, that is not true.

The applied program produced, although, small effects (1, 35 % and 6, 35 %), after all, we talk about a positive transformation, but not negative. Better improvement it is possible to achieve by different kind of stretching training and exercises before, during and after every workout. Once again, we emphasize that weight and plyometrics training do not change flexibility in a negative way. The program produced effects only on one (a figure eight running – 5 %) of three variables for agility estimation. This fact can be considered as a deficiency of applied program because some other studies, as research conducted by Michael G. Miller et al. (2006) with the purpose of the study to determine if six weeks of plyometric training can improve an athlete's agility, assessed by two tests T-test and Illinois Agility Test.

They confirmed that plyometric training can be an effective training technique to improve an athlete's agility. Probably, their program involved bigger number of sprint exercises with quick change of direction, while that was not a case in our program. Also, this incompatibility can be a result of different tests that been used in this research.

## Conclusion

The twelve weeks combined fitness program has produced statistically significant partial quantitative effects on students' motor abilities, so it can be said, that established hypothesis is confirmed. The applied program has generated improvement of fourteen variables of eighteen assessed variables. These changes are product of well planed and programmed work out, and individually, based on 1 RM, adjusted training load and intensity. The biggest changes are produced on variables for muscular static and dynamic endurance, what was expected in considerations of two facts: the first, the mentioned abilities are not high genetically determined, and the second, the program has been designed in order to improve a repetitive strength. Also, proportionally less, but not less significant changes have been produced on variables for explosive power estimation. These paper findings are compatible with other studies that examined effects of heavy weight and plyometrics training. A stereotypic belief, that weight training decrease flexibility, has been refused. Based on obtained results, it is obvious, that flexibility has been improved by the program, but not negatively influenced. The advantage of this research is getting information about the combined, weight and plyometrics training effects on big number of criterion variables, as was not a case in available literature.

The other studies, mostly tried to check effects of different programs on jumping performance. As a deficiency of this study, it can be taken a lack of experimental groups and control group, as can contribute to a reduced amount of reliable knowledge of the experimental program. This can be a construction of some future study. The applied program has proved its efficiency in motor abilities transformation and it could be a good method for students of sport faculty to improve and develop their motor capacities in order to easily pass all faculty duties, especially practical part of exams.

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#### KVANTITATIVNE PROMJENE MOTORIČKIH SPOSOBNOSTI STUDENATA NASTALE POD UTICAJEM KOMBINOVANOG DVANAESTOSEDMIČNOG FITNESS PROGRAMA

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##### Sažetak

Na uzorku od 36 studenata Fakulteta za tjelesni odgoj i sport, dobi  $19 \pm 1$  godina, primjenjen je kombinovani dvanaestosedmični fitnes program, koji se sastojao od dva treninga sedmično s tegovima u teretani i pliometrijskog treninga jedanput sedmično. Obzirom na cilj rada, da se utvrde eventualne parcijalne kvantitativne promjene testiranih motoričkih sposobnosti nastale pod uticajem provedenog programa, korišten je t-test za zavisne uzorke. Na osnovu dobijenih rezultata vidimo da je provedeni program proizveo statistički značajne promjene na 14 od testiranih 18 varijabli. Najveći nivo promjena desio se na varijablama za procjenu statičke i repetitivne snage, i to od 18 % do 55 %. Također, manje ali ne beznačajnije promjene evidentne su na testovima za procjenu eksplozivne snage, fleksibilnosti i segmentarne brzine. Individualno prilagođeno opterećenje svakom ispitaniku, zasigurno je proizvelo ove značajne promjene. Smatramo da bi program trebao biti ugrađen u redovni plan nastave na svim godinama, kako bi doprinjeo povećanju motoričkih kapaciteta studenata, te im olakšao put do cilja, završetka fakulteta.

**Ključne riječi:** fitnes program, motoričke sposobnosti, promjene, t-test za zavisne uzorke

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## SELECTION ORIENTED TOWARDS THE FUNCTIONAL ROLES OF THE INDIVIDUAL PLAYERS IN BASKETBALL

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Professional paper

### Abstract

*This essay examines the functional roles in basketball. It is mentioned that there are primarily five roles, and that we must take into consideration natural physiological demands stemming from the functional demands of the game. Although it seems that the number of roles could be determinate in a different manner, it is still a fact that five is a logical number, considering the structure of the game. We can create the players who do not fit the defined roles in this model, but their active participation will be limited to extreme situations, which are few and far between. The question is who would settle for that after 10-15 years of training? Or is there a child who would choose the role of a "wildcard" after the years of practice. It can happen that there is another model (sixth, seventh,...) in a profile of the basketball player, but those models are going to have hard time finding their purpose and role in the game, simply because the functional model of basketball is based on five roles called: functional roles of the individual players in basketball.*

**Key words:** basketball, roles, selection

### Introduction

Basketball is a sport in which five-men teams are trying to score as much points as possible by passing the ball through the hoop of the rivals, with the set of certain regulations. It was formulated by the Canadian James Naismith in 1891, when he made a set of basic rules and regulations. Although basketball is primarily an American sport, it soon became an international sport and today there is basically not a single country where it is not played. Basketball became an Olympic sport in 1936. This is a sport both for women and for men. It is played on a court 28 meters long and 15 meters wide, the height of the hoop is 3.05 meters, the hoop diameter is 51 cm, and the ball weighs around 650 grams.

The hoop is attached to a glass panel (180x120cm). Passing, handling and throwing the ball towards teammates is allowed. Only in some cases a player can cover the ground by carrying the ball, and only two steps are allowed. If the player holds the ball for more than five seconds, the ball is lost. Time for the offensive play is limited and it changed throughout the history. In today's European basketball the offensive play is limited to 24 seconds. When the ball is crossed over to an opponent's half (inside 10 sec), it cannot be brought back to your own half again.

Some contacts with the opponent are allowed (block, closing down), and in the case of the illegal contact, the team can be penalized with a foul, or even an intentional foul. In certain conditions free throws are awarded, and for that purpose a special position is marked on the court, and the team receives one point for each successful free throw.

The ball is thrown into play by a player who must stand outside the boundaries of the court, and it must be thrown to a player standing inside the court. The duration of the game varies, it is mostly divided into two 20 minute halves, or 12 minute quarters of the 'pure play', which means that when the ball is out of bounds, the time is stopped. There are usually 2 or 3 referees. There is a 'live' score sheet for each game. Modern basketball also has a three-point line, scoring behind that line is awarded with three points, and inside that line with two points.

### Problem and Aim

The introduction explained that basketball is a complex sport, which by its definition and general classification is a multistructural, acyclic sport activity. The winning requires cooperation between the teammates.

As each complex human activity requires specialization, the same goes for basketball. Namely, seen that a number of individuals participate in reaching of the common goal, and there is the identical tendency with the rivals, it is obvious that teammates cannot have identical roles inside the team, because the activity would be inefficient. Therefore, since the early days, and in accordance to the interests and capabilities, the individuals are specialized for certain roles in the game. This specialization, in this essay, will be characterized as a definition of the functional roles in basketball. That is **the problem** and the goal of **this essay**, most easily expressed as an analysis of the functional roles of the individuals for the adequate cooperation in the team.

### **Structure of the basketball team**

In every situation in sports, and especially in sports games, where several individuals work simultaneously, the basic question is asked: how many specialized roles should be defined in order to successfully implement a common activity? The minimum always equals one (1), which means that in that model all the players are prepared identically, and maximum always equals the number of players allowed on the court (5), which means that in this model different models of preparation are used, the players are prepared for their 'position in the game'.

The maximum can be more than 5 when we take into consideration bench players, in order to gain leverage in some segments of the game. Models of modern basketball game are used in accordance to various trainers' ideas, in which functional criteria have hierarchically different role and significance. That is expected, since some coaches put a stress on physical condition, some on technical preparation of the player, and some on tactical maneuvering in order to gain the advantage over the opponent.

In accordance to the initial logical position in the game, quality of the available players and the tactical knowledge, the game plan is defined, and functional criterion is incorporated and strengthened throughout the training sessions. However, seen that basketball has been analyzed and monitored for a long time, experts have differentiated 5 positions which are recognizable and applicable in modern basketball.

There are some discrepancies for the above mentioned reasons, but that does not change the general image, which is general even by its basic definition. Players' roles cannot be viewed separately from the general purpose of the game, so it is not difficult to identify some principles which simply should be understood as they are.

### Point guard

The court is large enough, and our opponents are trying to prevent **passing the ball to their own half**, and closer to the basket. That task can be achieved in two ways: a) passing the ball and b) dribbling. It is obvious that with the passing comes the danger of interception of the ball, but it is also the fact that it is the fastest way of moving the ball. On the other hand dribbling is much safer because the player with excellent ball handling skills can easily control the ball and win space, but this technique takes much more time than the first one.

As we cannot be certain if we are going to be able to conduct easy and accurate passing, because the opponent will see it as a great danger, and will try to stop it; starting five must have a player who is specialized in dribbling and ball handling in order to secure safe transition. That role of guarding the ball while taking it to opponent's half has a point guard, usually marked as '1'. The basic task of this player is to guard the ball until an opportunity for the efficient attack is presented. In order to fulfill that role, the point guard must have a good overview of the situation on the court, and ideally that player is at the back of the attacking formation, in order to have the option of passing the ball to teammates who are ideally in front of him.

His role does not end with just that task; he is also in charge of **ball distribution** according to the situation on the court, and to the possibilities which are intentionally created by his team. This in any case does not mean that point guard should not try to score. On the contrary, in every situation when the teammates are well covered, this player systematically tries to gain advantage, especially in counter-attacks and semi counter-attacks, when the opponent is defending with an incomplete defense formation.

### Guard

Since the basket is elevated to a certain height, it is clear that taller players will have an advantage over shorter players, and in many cases height advantage is decisive. So coaches always try to assemble a very tall team, and in the early days they select the children for whom is evident that they will be very tall. However, height difference is less important in the in-field play, as seen with the point guard who relies on other qualities rather than on height. As a support to the point guard, who can be isolated from the active play, we must have an alternative solution, and this player is marked as "2".

This mark comes from the defensive play where these two players create the first line of defense. If the game is functioning properly, the role of the guard is not a ball-transfer, but it is **creating the space around the basket, making himself available, and ultimately scoring**. As there is at least another seven players besides him in that space (his guards and three more pairs of players) it is obvious that there must be a player capable of long-range shooting. This is one of the key roles of the guard, **long-range shooting**. There is also the realization of quick counter-attacks if possible. Guards are in most situations the best and the most efficient players, which brings us to conclusion that their main purpose is scoring.

### Small forward

In order to be efficient both in the attack and the defense, and especially to establish dominance in the rebound area, we must have very tall players in our team, the players that cannot be dominated in efforts to get the ball after the miss. We can set the play so all of the players are good rebounders, and we will surely dominate that area of the game. But what if the entire game is different than we anticipated? What if there are a lot of slow attacks, with plenty of pre-arranged plays which take time develop, and the opponent has shorter and faster players? Then it is possible that there will be greater efficiency in scoring, with fewer shots, so our tall players will have nothing to fight for under the hoops. In that case the center of play is shifted inside the field (preparation of the attacking plays) where we need faster and more skilled defensive players, and in the attacking plays we need less static and more explosive players, still able to dominate under hoops.

These are the characteristics of the small, marked as "3". According to the functional description, small forward must be **tall but agile**, the player that can participate both in the **in-field play** but also in the game **in paint**. Since the defensive rebounds are not his primer goal, and defensively he guards the opponent of the similar characteristics, he is in a good position to realize **quick counter-attacks**.

With the organized attacking play, he is able to break through the defense with quick dribbling movements, and from the distance of 5-6 m in two-step movement crush the opponent's defensive lines and score. This is much more difficult for the first two players, simply because they have different tasks, and they are generally positioned much farther from the basket, so it is easier to stop them. This player is naturally moving sideways to the defense, which immediately threatens it, because it tends to deform it, no matter what type of defense is chosen. One of the desirable qualities is shooting accuracy, at least from the 4-6m distances, which is in today's training easy to achieve.

### Power forward

We have two more players to describe, one of them must be very tall in order to establish dominance in the defensive and offensive rebounding. The other one could be slightly shorter and quicker, the player which will give us certain agility and speed. The problem occurs when an opponent has a very tall player who is also accurate from mid-range distances (up to 5m). this player will naturally be positioned towards the outer positions, and as a consequence our tall player will follow.

If there is only one really tall player in our team, it means that we do not have any tall players in paint and we will lose the dominance under the basket. That being said, it is clear that we must have two really tall players, disregarding the fact that this will cause the loss of agility in the team, but on the other hand we will gain leverage in rebounding section. Also we want to put two tall players in the attacking plays in order to secure attacking rebounds, or to create actions so the can score easily. However there are two reasons why this is impossible. The first reason is that if two players stand close to each other, it is easier to guard them, and there forms a cluster of players making it difficult to create opportunities.

The other reason is so-called "three second rule", the rule that states that while attacking, the player can stand in the opponent's paint for only three seconds. This rule is created in order to prevent the tall players to "camp" under the hoops, which would ruin the game. The fourth player will be very tall and less agile than the small forward, and his basic goal is defensive play, defensive rebounds, and supporting the attacking plays. Such support can be: blocking, ball transfer, switching places with the small forward and the other tall player. The classic position of this player at the beginning of the attack is somewhere around the free-throw line, which means that he creates a connection between the guards and the forwards, but it also means that he must be accurate from the ranges of up to 4m, help with the rebounds both defensive and offensive, and moving towards the positions on the wing.

#### Center

This player is already mentioned in this analysis, and we already know that this is an extremely tall, strong player, which provides the team with the defensive rebounds, and possibly attacking rebounds, too. It is obviously a functional role realized with a lot of body contact, because none of the teams will allow free movement of a tall player under the basket, without exerting the

pressure, and trying to move him away from the basket. This means that our fifth player, usually called center ("5"), should be flawless in the execution of free throws after the fouls.

#### Conclusion

Functional roles in basketball have their logic, genesis, and purpose. The above mentioned model should not be considered final, because different solutions are needed, depending on a development of the game. It is not uncommon to have 4 fast players, when we want to steal the ball from the opponent, which weakens the rebound, but it is seen as necessary in given situation.

On the other hand, if the opponent's accuracy is low, or a lack of tall players, we can introduce three, or even four tall players. Finally if we want to indeterminate the game, we will introduce up to three small forwards, because they are a functional universal players, capable of creating unexpected solutions, which can surprise and confuse the opponent.

Generally the players will be prepared for one of the 5 roles mentioned, and as a team has 10-12 players signed up for the game, the selection of the starting five will be a tactical decision, and not up to functional roles, because there is still five of them.

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## SELEKCIJA ORIJENTISANA PREMA FUNKCIONALNIM ULOGAMA POJEDINIH IGRAČA U KOŠARKAŠKOJ IGRI

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### Sažetak

*U ovom radu se razmatraju funkcionalne uloge u košarci. Obrazloženo je da je broj tih uloga načelno pet, te da je u modelu sportske pripreme košarkaša potrebno posebnu pozornost usmjeriti na prirodne funkcionalne zahtjeve proizišle iz funkcionalnih ciljeva same igre. Iako se čini da se broj mogućih uloga može drugačije determinirati, ipak je činjenica da je taj broj logičan obzirom na strukturu same igre. Može se u procesu sportske pripreme „stvarati“ i igrače koji ne odgovaraju definisanim ulogama u ovom modelu, ali će njihovo aktivno sudjelovanje u igri biti ograničeno na ekstremne situacije, kojih je u regularnim sportskim takmičenjima jako mali broj. Pitanje je koji bi se igra nakon 10-15 godina sportske pripreme s tim zadovoljio? Ili koje bi dijete sa 10 godina izabralo ulogu da nakon 10-15 godina bude tek „joker“ za ograničenu upotrebu? Može se dogoditi da u nečijem profilu košarkaša egzistira i drugačiji (šesti, sedmi,...) model ali će takvi modeli jako teško pronaći svoje mjesto i ulogu, jednostavno zato što je funkcionalni model košarke, opisan u ovom radu definiran s pet pozicija nazvanih: funkcionalne uloge pojedinaca u košarkaškoj igri.*

**Ključne riječi:** košarka, uloge, selekcija

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