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Naučno-stručni časopis iz oblasti sportskih i medicinsko-rehabilitacionih nauka

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DRAGI ČITAOCI,

Pred Vama je novi broj Časopisa koji Vam nudi široku lepezu naučnih članaka iz oblasti kojima se bavimo ili srodnih njoj. Učešće su uzeli mnogi naši saradnici, naučni radnici iz Bosne i Hercegovine i regiona. Nastojimo da svaki broj bude kvalitetniji od prethodnog i ponudi nova saznanja iz oblasti sporta, zdravlja i šire i to ćemo činiti i ubuduće.

U ovom broju možete naći vrlo zanimljive radove iz atletike, rukometa, fudbala, karatea, plesa, ishrane i životne sredine, a prije svega, u kontekstu zdravlja vježbača, odnosno sportista. Naravno da nije izostavljen ni školski sport, tj. fizičko vaspitanje i obrazovanje.

Autorima radova hvala jer se trude da svojim istraživanjima unaprijede čovjeka, njegove sposobnosti, karakteristike i njegovo zdravlje. Recenzentima hvala, jer je njihovo oštro pero unaprijedilo svaki rad koji je objavljen u ovom broju Časopisa, a neke autore, odnosno radove, vratilo na preispitivanje i daljnje usavršavanje, kako bi možda u nekom sljedećem broju Časopisa, unaprijeđeni, i oni bili objavljeni.

Neka moto ovoga, 8. broja Časopisa, bude kineska narodna poslovice: „Svi cvjetovi budućnosti izrastaju iz korijena prošlosti“.

Uredništvo Časopisa

DEAR READERS,

We present you a new issue of the Journal offering a wide spectrum of areas of our concern and areas similar to them. In this Journal issue, many associates of ours, scientists from Bosnia and Herzegovina and region took part. We strive at making each new issue to be of better quality than the previous one and to offer new findings from the area of sports, health and others, and which we will also do in the future.

This issue contains very interesting papers from the area of athletics, handball, football, karate, dance, nutrition and environment, and first of all in the context of the health of an exerciser, i.e. athlete. Of course, sports in school, i.e. physical education was not left out.

We would like to express our greatest gratitude to the authors, for their efforts to improve a human being, its characteristics and its health by means of their research. Also, we would like to express our greatest gratitude to the reviewers, since their strict criticism improved each paper published in this issue of the Journal, while some papers of authors were sent back to be reviewed and further improved in order for such improved papers to be published in some of the next issues of the Journal.

Let the motto of this 8th issue of the Journal be a Chinese saying: „All future flowers grow from the roots of the past.“

Journal Editorial Board

VANNASTAVNA FIZIČKA AKTIVNOST DECE STARIJEG ŠKOLSKOG UZRASTA I NIVO KARDIORESPIRATORNE FORME

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Sažetak: Istraživanje sa ciljem procene vannastavne fizičke aktivnosti i fizičke forme sprovedeno je na uzorku od 333 učenika starijeg školskog uzrasta. Analize su sprovedene prema polu, školskom uzrastu i vannastavnoj fizičkoj aktivnosti. Učenici i učenice petih razreda su najmanje uključeni u vannastavnu fizičku aktivnost. Učenici su aktivniji u odnosu na učenice. Kod učenika i učenica koji nisu fizički aktivni vrednosti indeksa telesne mase su povišene (gojaznost kod fizički neaktivnih učenika je 5.2 – 6.2%, kod učenica 3.4 – 6.7%, dok je kod fizički aktivnih učenika 1.2-1.4%, i učenica 0.7-2.1%). Kod učenica, u svim analiziranim grupama zabeležena je gojaznost. Osim kod učenica petog razreda, između svih ostalih grupa ispitanika, zabeležena je statistički značajna razlika u odnosu na vrednosti kardiorespiratorne forme, u korist ispitanika koji su imali vannastavnu fizičku aktivnost. Kardiorespiratorna forma je uglavnom ispod nivoa dobrih u odnosu na optimalne kriterijume.

Ključne reči: fizička forma, zdravlje, gojaznost, deca.

Uvod

Srbija je među deset demografski najstarijih zemalja sveta, tako da danas u zemlji živi više starijih od 65 godina, nego mladih od 15. Zdravstveni i radni status današnje školske populacije, je zbog toga veoma bitan.

Stariji školski uzrast (uzrast od 11 do 15 godina) karakteriše proces rasta i psiho-fizičkog sazrevanja, socijalizacije, vaspitanja i školovanja. Zdravstveno stanje i kvalitet života u ovom periodu uslovljeni su mnogobrojnim faktorima, između ostalog, i odnosom prema fizičkoj aktivnosti. Redovna fizička aktivnost je od izuzetnog značaja, pošto je povezana sa zdravljem i dugovečnošću (Lee, Paffenbarger i Hennekens, 1997; Paffenbarger, Hyde, Wing i Hsieh, 1986), predisponiranošću ka gojaznošću (Goran i Treuth, 2001), psiho-fizičkim

EXTRACURRICULAR PHYSICAL ACTIVITY OF CHILDREN OF OLDER SCHOOL AGE AND CARDIORESPIRATORY FITNESS LEVEL

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Abstract: The basic goal of this study was to estimate extracurricular physical activity and physical fitness level on a sample of 333 children of older school age. Analyses were performed by gender, school age and extracurricular physical activities. Pupils of 5th grade were at least involved in extracurricular physical activity. Boys are more active than girls. For pupils who are not physically active body mass index values were increased (obesity rate in physically inactive boys was 5.2 - 6.2%, and girls 3.4 - 6.7%, whereas in physically active boys 1.2-1.4% and girls 0.7-2.1%). For schoolgirls, in all analyzed groups obesity was observed. Except in 5th grade, among all other groups of subjects was statistically significant difference compared to the values cardiorespiratory fitness in favor of the respondents who had extracurricular physical activity. Cardiorespiratory fitness is generally below the level of good as compared to norms for this age.

Key Words: physical fitness, health, obesity, children.

INTRODUCTION

Serbia is among the ten demographically oldest countries in the world, with more population over the age of 65 years old instead younger than 15. The health and employment status of today's school-age population is therefore very important.

Older school age children (ages 11 to 15 years) are characterized by the growth process and psycho-physical maturation, socialization, education and schooling. Health status and quality of life in this period are determined by many factors, among others, the attitude toward physical activity. Regular physical activity is of great importance, since it is associated with health and longevity (Lee, Paffenbarger & Hennekens, 1997; Paffenbarger, Hyde, Wing & Hsieh, 1986), predisposition to obesity (Goran

blagostanjem (Steptoe i Butler, 1996), i kognitivnom funkcionalnošću dece (Sibley i Etnier, 2003). Rizik po zdravstveni status školske dece predstavlja: hipokinezija i neadekvatna ishrana (gojaznost) koji su međusobno povezani, i koji u sinergiji dovode do poremećaja posturalnog statusa. Hipokinezija predstavlja nedovoljan nivo aktivnog kretanja, odnosno, nivo telesne aktivnosti, koji je hronično ispod praga nadražaja i koji omogućava održavanje funkcionalnog kapaciteta najvažnijih organskih sistema (Hollmann, 1975). Svetska zdravstvena organizacija (SZO) je proglasila hipokineziju za faktor rizika broj 1, kada je u pitanju ljudsko zdravlje, a posebno ugrožene kategorije su deca i adolescenti. Kardiovaskularna oboljenja nisu karakteristična za dečiji uzrast, ali istraživanja ukazuju da deca sa manjom fizičkom aktivnošću imaju predispoziciju ka riziku od ovih oboljenja (Wedderkopp, Froberg, Hansen, Riddoch i Andersen, 2003; Boreham i Riddoch, 2001). Nedovoljan nivo fizičke aktivnosti dovodi do nastanka gojaznosti, koje je najštetnija posledica neaktivnosti (Pretience i Jebb, 1995). Gojaznost je hronična bolest koja se ispoljava prekomernim nakupljanjem masnog tkiva u organizmu i povećanjem telesne mase, a u kliničkoj praksi najčešće iskazuje preko indeksa telesne mase (Tsigos i sar., 2008). SZO je gojaznost je okarakterisala kao epidemiju (WHO, 2000). U dečijem uzrastu bitno utiče na zdravlje i kvalitet života deteta, i vodi ka ozbiljnim zdravstvenim oboljenjima u odrasloj dobi: diabetes Tipa 2, povišen krvni pritisak i kardiovaskularna oboljenja (Cameron i sar., 2003; Guo i sar., 2000; Whitaker, Wright, Pepe, Seidel i Dietz, 1997; Power, Lake i Cole, 1997). Ponašanje deteta igra jednu od ključnih uloga u razvoju gojaznosti (Burke, 2006), pre svega podrazumevajući način ishrane i nivo fizičke aktivnosti. Sedentarni način života i povećana telesna težina, zajedno, sistematski deluju i dovode do pojave i razvoja lošeg držanja tela, odnosno telesnih deformiteta.

Fizička forma predstavlja merljivu komponentu navika pojedinca po pitanju učešća i fizičkoj aktivnosti i vežbanju. Američki koledž za sportsku medicinu naveo je razloge za procenu elemenata fizičke forme (ACSM, 2009), prvi, predstavlja usmeren ka edukaciji ispitanika o trenutnom nivou elemenata fizičke forme, i poređenje dobijenih parametara sa standardima za pol i uzrast, drugi je primena dobijenih rezultata za dizajniranje programa vežbanja. Fizička forma povezana sa zdravljem, definisan je kao skup pet različitih i merljivih elemenata fizičke forme koji su povezani sa optimalnim zdravstvenim statusom, a koji obuhvataju kardiorespiratornu formu, telesnu strukturu, mišićnu snagu, mišićnu izdržljivost i fleksibilnost (ACSM, 2010).

& Treuth, 2001), psycho-physical well-being (Steptoe & Butler 1996), and cognitive functionality of children (Sibley & Etnier, 2003). Risk to health status of school children presents: hypokinesia and inadequate nutrition (obesity), which are linked, and in synergy lead to disorders of postural state. Hypokinesia represents an insufficient level of active movement, i.e., the level of physical activity, which is below the threshold of chronic stimuli that allows the maintenance of the functional capacity of most organ systems (Hollmann, 1975). The World Health Organization (WHO) has declared hypokinesia for a risk factor number one to human health, especially vulnerable are categories of children and adolescents.

Cardiovascular diseases are not characteristic in childhood, but research suggests that children with less physical activity have a predisposition of risk of these diseases (Wedderkopp, Froberg, Hansen, Riddoch & Andersen, 2003; Boreham & Riddoch, 2001). Low levels of physical activity lead to the development of obesity, which is the most harmful consequences of inactivity (Pretience & Jebb, 1995). Obesity is a chronic disease that is manifested by excessive accumulation of fat in the body and increasing body mass, and in clinical practice, usually expressed through body mass index (Tsigos et al., 2008). WHO characterized obesity as epidemic (WHO, 2000), and in childhood significantly affects the health and quality of life, and leads to serious health disorders in adulthood: Diabetes Type 2, high blood pressure and cardiovascular disease (Cameron et al., 2003; Guo et al., 2000; Whitaker, Wright, Pepe, Seidel & Dietz, 1997; Power, Lake & Cole, 1997).

The child's behavior plays a key role in the development of obesity (Burke, 2006), primarily by assuming diet and level of physical activity. Sedentary lifestyles and increased body weight, together systematically lead to the appearance and development of poor posture and physical deformities.

The physical fitness is a measurable component of the individual in terms of participation and physical activity and exercise. The American College of Sports Medicine noted reasons for the assessment of the elements of physical fitness (ACSM, 2009), first, is directed towards educating about the current level of physical fitness elements, and comparison of the parameter standards for age and sex, the second is the application of the results obtained for designing exercise program.

Health related physical fitness is defined as a set of five different elements and measurable physical forms which are associated with optimal health status, and include: cardiorespiratory fitness, body structure, muscular strength, muscular endurance and flexibility (ACSM, 2010).

Kardiorespiratorna forma definiše se kao sposobnost kardiovaskularnog i respiratornog sistema da dopreme kiseonik do aktivne muskulature tokom kontinuirane fizičke aktivnosti, odnosno, sposobnost organizma da kontinuirano izvodi pokrete velikim grupama mišića umerenog do visokog intenziteta. Visok nivo kardiorespiratorne forme u detinjstvu i adolescenciji je povezan sa zdravstvenim stanjem kardiovaskularnog sistema tokom ovih godina (Mesa i sar., 2006 a,b), i kasnije u toku života (Ruiz i sar., 2006 a, b). Kardiorespiratorna forma, se u najčešće identifikuje sa aerobnom sposobnošću, odnosno, maksimalnom potrošnjom kiseonika (VO_{2max}) koja je izražena u l/min, ml/kg/min ili MET-ima. Najvažniji simptom hipokinezije je upravo smanjenje aerobne sposobnosti (Čizmić, 1992; Saltin i Rowel, 1980).

Problem istraživanja je utvrđivanje elemenata fizičke forme povezane sa zdravljem učenika, koja može da posluži kao evaluacija kurikuluma fizičkog vaspitanja.

METOD RADA

Uzorak ispitanika činilo je 333 učenika (156 učenika i 177 učenica), starijeg školskog uzrasta, od petog do osmog razreda osnovnih škola na teritoriji grada Novog Sada. Kao kriterijumska, korištena je varijabla (analiza grupe ispitanika) koja je dobijena anketom: REDOVNO VEŽBANJE – sa tri odgovora: gotovo nikad (jednom nedeljno ili nijednom), često (2-3 puta nedeljno) i uvek (više od 3 puta nedeljno). Za procenu morfološkog statusa, korištene su tri varijable: TELVIS – telesna visina, TELMAS – telesna masa i BMI – indeks telesne mase (body mass index). Prilikom merenja vrednosti antropometrijskih parametara, korišćen je Internacionalni biološki program (Weiner i Lourie, 1969). BMI je dobijen formulom ($kg/m^2 = \text{težina}(kg) / \text{visina}(m)^2$), a klasifikacija ispitanika prema vrednostima prekomerne uhranjenosti i gojaznosti za decu i adolescente (Cole, Bellizzi, Flegel i Dietz, 2000). Za procenu kardiovaskularne forme korišten je: SHUTTLE (Shuttle run test) (Eurofit, 1993). Analize su sprovedene prema polu (učenici / učenice), školskom uzrastu (razredi) i vannastavnoj fizičkoj aktivnosti. Za dobijene rezultate izračunati su deskriptivni statistički parametri (aritmetička sredina i standardna devijacija). Za utvrđivanje značajnosti razlika između grupa ispitanika primenjen je Studentov t - test za nezavisne uzorke ($p < 0.01$). Za sva izračunavanja korišten je aplikacijski statistički program SPSS za windows, 17.0.

REZULTATI

Redovnost vannastavne fizičke aktivnosti u odnosu na razred i na pol ispitanika prikazana je u Tabeli 1.

Cardiorespiratory fitness is defined as the ability of the cardiovascular and respiratory systems to supply the oxygen to active muscles during continuous physical activity, that is, the body's ability to continuously perform movements of large muscle groups of moderate to high intensity. The high level of cardiorespiratory fitness in childhood and adolescence is associated with the health of the cardiovascular system during these years (Mesa et al., 2006a, b), and later in life (Ruiz et al., 2006a, b). Cardiorespiratory fitness is the most commonly identified with the aerobic capacity, i.e., maximal oxygen consumption (VO_{2max}), which is expressed in l/min, ml/kg/min or MET's. The most important symptom of hypokinesia is precisely the reduction of aerobic ability (Čizmić, 1992; Saltin & Rowel, 1980).

The main research problem was to determine the elements of Health related physical fitness (cardiorespiratory fitness) of school children, which can be used as an evaluation of the physical education curriculum.

METHOD

The sample consisted of 333 schoolchildren (156 boys and 177 girls), older school age from 5th to 8th grade primary school in the city of Novi Sad.

As a criterion, we used the variable (for analysis of respondents groups) that was obtained by the survey: Regular exercise - with 3 answers: almost never (once a week or never), often (2-3 times a week) and always (more than 3 times per week).

To assess the morphological status, three variables were used: TELVIS - height, TELMAS - body weight and BMI - body mass index. For anthropometric measurement, International Biological Program (Weiner & Lourie, 1969) was used. BMI is obtained by the formula ($kg/m^2 = \text{weight}(kg) / \text{height}(m)^2$), a classification of children was done according to the values of overweight and obesity in children and adolescents (Cole, Bellizzi, Flegel & Dietz, 2000). To assess cardiovascular fitness SHUTTLE (Shuttle run test) (Eurofit, 1993) was used. Analyses were performed by sex (boys/girls), school grades and extracurricular physical activities.

For all results descriptive statistical parameters (mean and standard deviation) were calculated. To determine the significance of differences between groups of patients a Student t - test for independent samples was applied ($p < 0.01$). For all calculations statistical program SPSS for Windows 17.0 was used.

RESULTS

Regularity of extracurricular physical activity in relation to class and gender of respondents is shown in

Ispitanici 5-og razreda su najmanje uključeni u vannastavnu fizičku aktivnost, dok učešće sa godinama raste iz razreda u razred, kao i da su učenici aktivniji u odnosu na učenice.

Tabela 1. Redovnost vannastavne fizičke aktivnosti učenika i učenica

| Uzrast / Class | Dečaci / Boys | Devojčice / Girls |
|-----------------------------------|---------------|-------------------|
| 5. razred / 5 th grade | 1.33 | 1.27 |
| 6. razred / 6 th grade | 2.33 | 2.30 |
| 7. razred / 7 th grade | 2.33 | 2.31 |
| 8. razred / 8 th grade | 2.73 | 2.47 |

Gotovo nikad (1 bod); Često (2 boda); Uvek (3 boda)

U tabeli 2 i 3 prikazane su morfološke karakteristike, vrednosti indeksa telesne težine i procenat gojaznih u odnosu na grupe (prema učešću u vannastavnim fizičkim aktivnostima).

Tabela 2. Morfološke karakteristike učenika

| Uzrast / Age | Dečaci / Boys | | | |
|---------------------------------------|---------------|-----------|------------|-------------------|
| | TELVIS | TELMAS | BMI | Gojazni / Obesity |
| 11 godNA (n=13) / 11 yearsNA (n=13) | 1.50±0.08* | 42.8±7.3 | 19.02±2.39 | 6.2% |
| 11 godFA (n=27) / 11 yearsPA (n=27) | 1.49±0.07 | 47.8±5.3 | 21.46±2.55 | 1.4% |
| 12 god NA (n=27) / 12 years NA (n=27) | 1.66±0.01 | 48.5±11.5 | 19.03±2.68 | 5.2% |
| 12 godFA (n=18) / 12 yearsPA (n=18) | 1.65±0.01 | 50.9±11.1 | 19.61±2.78 | - |
| 13 god NA (n=11) / 13 years NA (n=11) | 1.70±0.02 | 64.0±6.5 | 22.10±2.29 | 6.2% |
| 13 godFA (n=17) / 13 yearsPA (n=17) | 1.70±0.07 | 56.5±5.8 | 20.73±1.74 | - |
| 14 god NA (n=18) / 14 years NA (n=18) | 1.69±0.05 | 57.2±10.8 | 20.82±2.13 | 5.5% |
| 14 godFA (n=25) / 14 yearsPA (n=25) | 1.71±0.06 | 58.6±5.7 | 20.03±0.78 | 1.2% |

* Aritmetička sredina – standardna devijacija

Kod učenika koji nisu fizički aktivni vrednosti indeksa telesne mase su povišene i u tim grupama je zastupljen veći procenat gojaznih. Procenat gojaznih kod fizički neaktivnih kreće se od 5,2 – 6,2%, dok je kod fizički aktivnih učenika 1,2-1,4%.

Tabela 3. Morfološke karakteristike devojčica

| Uzrast | Devojčice / Girls | | | |
|---------------------------------------|-------------------|----------|------------|-------------------|
| | TELVIS | TELMAS | BMI | Gojazni / Obesity |
| 11 godNA (n=13) / 11 yearsNA (n=13) | 1.57±0.11 | 43.4±4.9 | 19.70±1.96 | 5.5% |
| 11 godFA (n=33) / 11 yearsPA (n=33) | 1.53±0.11 | 46.2±8.6 | 19.48±2.63 | 1.7% |
| 12 god NA (n=15) / 12 years NA (n=15) | 1.50±0.05 | 45.5±0.1 | 20.05±1.35 | 3.4% |

Table 1. Respondents of 5th grade are least involved in extracurricular physical activity, and participation increases with age from grade to grade, and boys are more active than girls.

Table 1. Regularity of extracurricular physical activity of pupils

Almost never (1 point); often (2 point); always (3 points)

Table 2 and 3 shows the morphological characteristics, body mass index and obesity rates in relation to the analyzed groups (by participation in extracurricular physical activities).

Table 2. Morphological characteristics of boys

* Arithmetic mean - Standard deviation

For boys who are less physically active, body mass index was increased, and in these groups higher percentage of obese was noticed. Obesity in physically non-active varies from 5.2 - 6.2%, while the physically active boys is 1.2-1.4%.

Table 3. Morphological characteristics of girls

| | | | | |
|---------------------------------------|-----------|----------|------------|------|
| 12 godFA (n=36) / 12 yearsPA (n=36) | 1.59±0.10 | 50.9±8.2 | 20.18±2.58 | 0.7% |
| 13 god NA (n=12) / 13 years NA (n=12) | 1.69±0.05 | 61.3±2.5 | 22.34±1.82 | 4.2% |
| 13 godFA (n=19) / 13 yearsPA (n=19) | 1.70±0.01 | 55.5±4.5 | 19.35±1.45 | 1.5% |
| 14 god NA (n=20) / 14 years NA (n=20) | 1.68±0.04 | 52.7±5.1 | 22.55±1.48 | 6.7% |
| 14 godFA (n=25) / 14 yearsPA (n=25) | 1.70±0.06 | 53.3±1.5 | 21.99±2.39 | 2.1% |

Može se zaključiti da su kod učenica koji nisu fizički aktivne, vrednosti indeksa telesne mase povišene i zastupljen je veći procenat gojaznih, baš kao i kod učenika. Kod učenica u svim analiziranim grupama zabeležena je gojaznost, bez obzira da li su ili nisu fizički aktivne, procenat gojaznih kod fizički neaktivnih kreće se od 3,4 – 6,7%, dok je kod fizički aktivnih učenica 0,7-2,1%.

U tabeli 4 prikazane su vrednosti kardiorespiratorne forme (VO_{2max}) za uzorak ispitanika i rezultati Studentovog t testa.

Tabela 4. Vrednosti VO_{2max} prema godinama i polu

| Maksimalna potrošnja kiseonika VO_{2max} (ml/kg ⁻¹ .min ⁻¹) / Maximal oxygen consumption VO_{2max} (ml/kg ⁻¹ .min ⁻¹) | | | | | | |
|---|---------------|------------|--------------|-------------------|------------|--------------|
| Uzrast / Age | Dečaci / Boys | | | Devojčice / Girls | | |
| | NA | FA | p | NA | FA | p |
| 11 god. / years | 37.42±3.81* | 45.76±8.47 | 0.000 | 33.46±1.67 | 34.12±2.55 | 0.371 |
| 12 god. / years | 34.58±4.19 | 39.29±4.61 | 0.003 | 32.85±2.85 | 37.18±4.73 | 0.008 |
| 13 god. / years | 33.44±5.42 | 42.50±6.39 | 0.000 | 37.87±1.72 | 46.61±1.48 | 0.001 |
| 14 god. / years | 27.56±5.16 | 32.81±3.79 | 0.003 | 32.24±4.56 | 36.52±4.34 | 0.009 |

VO_{2max} – maksimalna potrošnja kiseonika

NA – fizički neaktivni; FA – fizički aktivni

*Aritmetička sredina standardna devijacija

p – Rezultati Studentovog t-testa za nezavisne uzorke ($p < 0.01$)

Osim kod učenica petog razreda, između svih ostalih grupa ispitanika, zabeležena je statistički značajna razlika u odnosu na vrednosti kardiorespiratorne forme, u korist ispitanika koji su imali vannastavnu fizičku aktivnost.

DISKUSIJA

Prema normativima vrednosti VO_{2max} za uzrast 10-14 godina (Karila, Blic, Waerbessyckle, Bernoist i Scheinmann, 2001), svi zabeleženi rezultati učenika koji nisu fizički aktivni nalaze se u zoni veoma slabih rezultata. I kod fizički aktivnih učenika, rezultati su rangirani kao prosečni (5. razred), slabi (6. i 7. razred) i veoma slabi kada su u pitanju učenici 8. razreda. Kod učenica, veoma slabi rezultati zabeleženi su kod uzrasta 6. i 8. razreda koje nisu fizički aktivne, slabi rezultati u 5. razredu i do-

It can be concluded that girls who are not physically active, have higher body mass index value and higher percentage of obese, as well as boys. In all analyzed groups (girls) obesity was observed, whether they are physically active or not. Obesity rates in physically inactive vary from 3.4 - 6.7%, while in physically active schoolgirls ranged from 0.7-2.1%.

Table 4 shows the cardiorespiratory fitness (VO_{2max}) for the sample of children and the results of the Student t test.

Table 4. Values of VO_{2max} by age and gender

VO_{2max} – maximal oxygen consumption

NA – non active; PA – physically active

*Arithmetic mean - Standard deviation

p – Results of the Student t test ($p < 0.01$)

Except for a 5th grade girls, among all other groups of children there was statistically significant difference compared to the values of cardiorespiratory fitness in favor of children who had extracurricular physical activity.

DISCUSSION

According to the norms of VO_{2max} for ages 10-14 years (Karila, Blic, Waerbessyckle, Bernoist & Scheinmann, 2001), all observed results of the pupils which are less physically active are in the zone of very weak results. And in physically active pupils, the results were ranked as regular (5th grade), weak (6th and 7th grade) and very weak when it comes to 8th grade pupils.

For schoolgirls very weak results were observed in aged 6th and 8th grade, for those which are not physically

bri rezultati u 7. razredu. Učenice koje su fizički aktivne zabeležile su odlične rezultate u 7. razredu, prosečne rezultate u 6. i 8. razredu i slabe rezultate u 5. razredu. I na osnovu testiranja učenika osnovnih škola u Srbiji (Gajević, 2009) u ispoljenim motoričkim i funkcionalnim sposobnostima zaostajemo za prosekom školske populacije zemalja EU. Nažalost, rezultati i ove studije se uklapaju u trend da se broj mladih koji se bave fizičkom aktivnošću smanjuje (Brooks i Magnusson, 2006). Činjenice da su učenici aktivniji u odnosu na učenice, ukazuju da postojeća nastavna praksa ne izlazi u susret specifičnim potrebama i afinitetima devojčica (Đorđić i Tumin, 2008). Dečaci predstavljaju homogeniju grupu, kad je reč o percepciji različitih aspekata fizičkog vaspitanja (vannastavnoj fizičkoj aktivnosti). Jedan od mogućih uzroka, neaktivnosti je kvalitet nastave fizičkog vaspitanja, sa relativno malim brojem aktivnosti i orijentacijom na sportska takmičenja i sticanje motoričkih znanja (Hardman, 2008; 2007). Fizičko vaspitanje treba da omogući učenicima da steknu značajan deo preporučene dnevne doze fizičke aktivnosti, ali i znanja o važnosti iste za ceo život (Scruggs i sar., 2003). Nastavnik je ključni faktor motivacije učenika i promovisanja fizičke aktivnosti, te su učenici koji su zadovoljni na časovima fizičkog vaspitanja, mnogo aktivniji fizički van škole (Vilhjamsson i Thorlindsson, 1998). Za poboljšanje fizičke forme dece, potrebna je i edukacija odraslih (roditelja), jer od njihovih stavova prema vežbanju zavisi i učešće njihove dece (Mikalački, Čokorilo i Pantelić, 2006; Tubić, 2006). Američka nacionalna asocijacija za sport i fizičko vežbanje, predlaže svakodnevno fizičko vežbanje u trajanju od 45 minuta za više razrede i srednju školu kumulativno kroz časove fizičkog vaspitanja i sve druge oblike dnevnih aktivnosti. Fizički aktivna deca su manje sklona hroničnim oboljenjima (Casparsen, Nixon i DuRant, 1998), metaboličkim problemima (Moore, Nguyen, Rothman, Cupples i Ellison, 1995), a postoji i velika mogućnost da u odraslom dobu budu fizički aktivna (Malina, 1996). Aktivan način života i svakodnevna fizička aktivnost ima značajnu ulogu u prevenciji nastanka gojaznosti (DiPietro, 1999). Posebno je ugrožena populacija neaktivnih devojčica, koje imaju jaču povezanost između gojaznosti i kardiovaskularnih oboljenja (Burke i sar., 2005).

Praćenje i kontrola kardiovaskularne forme je od izuzetne važnosti kroz ceo život (Malina, 1996) zbog povezanosti sa rizikom od kardiovaskularnih oboljenja i gojaznosti (Ostojić, Stojanović, Stojanović, Marić i Njaradi, 2011; Ruiz, Rizzo, Wennlof, Ortega, Harro i Sjostrom, 2006). Takođe, kardiovaskularna forma u periodu detinjstva je povezana sa povećanim rizikom od goja-

active, weak results in the 5th grade and good results in 7th grade. Schoolgirls which are physically active have obtained excellent results in 7th grade, regular results in 6th and 8th grade and weak results in the 5th grade. The results of motor and functional abilities tests of children of primary schools in Serbia (Gajević, 2009) are inferior when compared to the average school population in EU countries. Unfortunately, the results of this study fit into the trend that the number of young people who are engaged in physical activity decreases (Brooks & Magnusson, 2006). The fact that boys are more active, indicate that the existing teaching practice does not meet the specific needs and preferences of girls (Đorđić & Tumin, 2008).

Boys are more homogeneous group when it comes to perceptions of various aspects of physical education (extracurricular physical activity). One of the possible causes of inactivity is the quality of physical education classes, with a relatively small number of activities and orientation in sports competitions and development of motor skills (Hardman, 2008; 2007).

Physical education should enable pupils to gain significant load of recommended daily physical activity, but also and knowledge about the importance of the same for the entire life (Scruggs et al., 2003). The teacher is a key factor in pupil's motivation and promotion of physical activity, and pupils who are satisfied in physical education classes, are more physically active outside of school (Vilhjamsson & Thorlindsson, 1998).

To improve the physical fitness of children, education of adults (parents) is needed because participation of their children is depended on their attitudes to physical activity (Mikalački, Čokorilo & Pantelić, 2006; Tubić, 2006). The US National Association for Sport and physical exercise suggests 45 minutes of physical activity daily for higher grades and high school children, cumulative through physical education classes and all other forms of daily activities. Physically active children are less prone to chronic diseases (Casparsen, Nixon & DuRant, 1998), metabolic problems (Moore, Nguyen, Rothman, Cupples & Ellison, 1995), and there is a strong possibility that, in adulthood, they will be physically active (Malina, 1996). Active lifestyle and daily physical activity plays an important role in the prevention of obesity (DiPietro, 1999). Particularly vulnerable is population of inactive girls, who have a strong correlation between obesity and cardiovascular disease (Burke et al., 2005).

Monitoring and control of cardiovascular fitness is essential for the whole life (Malina, 1996), because of its association with the risk of cardiovascular disease and obesity (Ostojić, Stojanović, Stojanović, Marić & Njaradi,

znosti i drugim metaboličkim poremećajima u odraslom periodu (Dwyer i sar., 2009; Cleland, Dwyer i Venn, 2008; Ferreira, Twisk, Stehouwer, Van Mechelen i Kemper, 2003). Kod dece, niži nivo fizičke forme povezan je sa umanjnim kognitivnim funkcijama koje zahtevaju pažnju, pamćenje i kognitivnu kontrolu (Kamijo i sar., 2012a; Hillman, Buck, Themanson, Pontifex i Castelli, 2009), kao i sa umanjnim ostvarenjima u učenju (Kamijo i sar., 2012b; Castelli i sar., 2003).

ZAKLJUČAK

Učenici petih razreda, su najmanje uključeni u vannastavnu fizičku aktivnost, dok su učenici su aktivniji u odnosu na učenice. Učenici koji nisu fizički aktivni imaju povišene vrednosti indeksa telesne mase, i zastupljen veći procenat gojaznih. Kod učenica, u svim analiziranim grupama zabeležena je gojaznost, bez obzira na vannastavnu fizičku aktivnost. Osim kod učenica petog razreda, između svih ostalih grupa ispitanika, zabeležena je statistički značajna razlika u odnosu na vrednosti kardiorespiratorne forme, u korist ispitanika koji su imali vannastavnu fizičku aktivnost. Svi zabeleženi rezultati su uglavnom ispod nivoa dobrih u odnosu na optimalne kriterijume za ovaj uzrast.

Praćenje parametara fizičke forme povezane sa zdravljem treba da postane praksa od polaska dece u školu, kako bi se na vreme moglo uticati na nepovoljne faktore koji mogu ugroziti zdravlje, i iskoristili benefiti fizičke aktivnosti.

Izjava autora

Autori pridonijeli jednako.

Konflikt interesa

Mi izjavljujemo da nemamo konflikt interesa.

2011; Ruiz, Rizzo, Wennlof, Ortega, Harro & Sjostrom, 2006)). Also, cardiovascular fitness in period of childhood is related with an increased risk of obesity and other metabolic disorders in adulthood (Dwyer et al., 2009; Cleland, Dwyer & Venn, 2008; Ferreira, Twisk, Stehouwer, Van Mechelen & Kemper, 2003). In children, lower levels of physical fitness is associated with reduced cognitive functions that require attention, memory and cognitive control (Kamijo et al., 2012a; Hillman et al., 2009), and diminished achievements in learning (Kamijo et al., 2012b; Castelli et al. 2003).

CONCLUSION

Fifth grade pupils are least involved in extracurricular physical activity and boys are more active than girls. Schoolchildren which are less physically active have higher values of body mass index, and higher percentage of obese. For schoolgirls, in all analyzed groups obesity was observed, regardless of extracurricular physical activity. Except for a fifth grader, among all other groups of children there was statistically significant difference compared to the values of cardiorespiratory fitness in favor of the respondents who had extracurricular physical activity. All results observed are generally below the level of good as compared to the optimum norms for this age group.

Monitoring parameters of health related physical fitness should become common practice since the start of the school in order to affect the unfavorable factors, that may threaten the health, and to use the benefits of physical activity.

Authorship statement

The authors have contributed equally.

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MATRIČNA FORMA KOMPROMISNE OPTIMIZACIJE FUNKCIONALNE ISHRANE

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Rezime: Funkcija ishrane ljudskog organizama jeste da se obezbijede hranljivi sastojci potrebni za njegovo optimalno funkcionisanje. Poznato je da se zahtjevi ishrane razlikuju prema zdravstvenom stanju, fizičkoj konstituciji, starosti, polu, psihofizičkom opterećenju i drugim internim i eksternim faktorima svakog pojedinca.

Moderan način života karakterišu, pored ostalog, nekvalitetna, neredovna ishrana u kombinaciji sa intenzivnim psihičko – psihološkim opterećenjima, pretežno „sjedelački“ životni stil, nedovoljno kretanje i izostanak boravka u prirodi. Takav stil života intenzivno korelira sa brojnim zdravstvenim problemima, pri čemu se brojni mogu prevenirati, pa i „liječiti“ formulacijom adekvatne ishrane, čija struktura i kvalitet podižu funkcionalnu potentnost ljudskog organizma kao složenog sistema.

Jedna od osnovnih karakteristika sistema sastoji se u tome da se promjene na jednom elementu direktno ili posredno reflektuju na sistem kao cjelinu. Brojni su pokušaji da se „propišu“ adekvatni programi ishrane, koji u velikom broju uzrokuju rezistenciju korisnika, jer se odnose na ograničavanje, izbacivanje pojedinih namirnica, zatim nemogućnost ili nepristupačnost propisanih komponenti jelovnika, neadaptivnost i nefleksibilnost programiranih režima ishrane.

Ishrana ljudskih organizama, kao složenih sistema, treba da omogućući odgovarajući kvalitet koji se iskazuje i mjeri sadržajem ugljikohidrata, masnoća, proteina, vode, vitamina i minerala sa jedne strane, sa potrebama, mogućnostima, dostupnošću pojedinih namirnica, platežnom moći i ličnim preferencijama individualnih korisnika sa druge strane. Podizanje stepena fleksibilnosti, adaptivnosti, dostupnosti programa ishrane usklađene sa individualnim zahtjevima i potrebama različitih korisnika uz očuvanje potrebne visine kvaliteta i kvantiteta iste, moguće je postići i održavati korištenjem optimizacionih modela iz sfere kompromisnog programiranja.

Ključne riječi: individualne potrebe, kvalitet ishrane, kompromisno programiranje, funkcionalna potentnost.

Uvod

Brojna ispitivanja iz oblasti zdravstvenih nauka porvrđuju hipotezu da kvalitet i kvantitet ishrane korelira sa zdravstvenim stanjem ljudskog organizma. Pored

MATRIX FORM OF COMPROMISING OPTIMIZATION OF FUNCTIONAL NUTRITION

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Abstract: The function of human nutrition is to provide necessary nutrients for its optimal functioning. It is a well-known fact that nutrition requirements differ based on the health, physical constitution, age, gender, psychophysical load and other internal and external factors of each individual.

A modern way of life is characterized, *inter alia*, as of poor quality, irregular diet in combination with intensive psychological loads, predominantly a static life style ("sitting"), insufficient exercise and lack of outdoor activities. Such life style intensively correlates with numerous health problems where most of such problems can be prevented, even "treated" by formulating an adequate diet whose structure and quality increase the functional potency of the human organism as a complex system.

One of the basic characteristics of such system is reflected in the fact that changes in one element are directly or indirectly reflected on the system as a whole. Attempts to "prescribe" an adequate diet programs are numerous, which to a great extent can cause the resistance of a consumer since such programs are related to the limitations, exclusion of some nutrients, and impossibility or inaccessibility of the prescribed diet components, non-adaptiveness and inflexibility of the programmed diet regimes.

Nutrition of human organisms, as complex systems, should provide an appropriate quality expressed and measured by the content of carbohydrates, fat, proteins, water, vitamins and minerals on one hand, and needs, possibilities, accessibility of certain nutrients, affordability and personal preferences of individual consumers on the other hand. The increase of level of functionality, adaptiveness, and accessibility of a diet program adjusted to individual requirements and needs, along with the maintenance of necessary high quality and quantity of the same, can be achieved by using optimizing models from the sphere of compromising programming.

Key words: individual needs, nutrition quality, compromise programming, functional potency.

INTRODUCTION

Numerous researches from the area of health science confirm the hypothesis that the quality and quantity of nutrition correlates with a state of health of the human

toga, empirija potvrđuje činjenicu da suptilno balansiranje ishrane omogućava podizanje nivoa funkcionalno – zdravstvene potentnosti ljudskog organizma, sa jedne strane, kao i višestruko potvrđena činjenica direktnog i intenzivnog kauzaliteta brojnih funkcionalnih disbalansa u odnosu na strukturne karakteristike ishrane, sa druge strane.

Ukoliko ljudski organizam shvatimo, posmatramo i analiziramo kao složeni sistem, potrebno je da izbalansiranim pristupom struktuiramo ulazni vektor u svrhu postizanja željene (ciljane) vrijednosti izlaznih veličina. Metoda istraživanja je matematičko modeliranje strukture i funkcionisanja ljudskog organizma sa aspekta optimalnog funkcionisanja.

Svrha cilj i uspjehnost metodologije modeliranja ogleđa se u uspjehnosti istraživača da konstruiše model koji je „vjerna kopija realnog sistema, odnosno originala“ (Landika, 2010).

Jasno je da se struktura ulaznog vektora odnosi na kvalitet i kvantitet ishrane, a koordinate izlaznog vektora odnose se na performanse ljudskog organizma odnosno psihofizičke potentnosti i opšte zdravstveno stanje. Pod opštim zdravstvenim stanjem podrazumijevamo težinu, BMI (engl. Body Mass Index, indeks tjelesne mase), rezultate laboratorijske analize krvi, visine krvnog pritiska i rezultate brojnih medicinsko – laboratorijskih pretraga usklađenih individualnim potrebama korisnika.

Prilagoditi obim i strukturu ishrane potrebama i preferencijama svakog pojedinog korisnika sa postizanjem željenih izlaznih veličina, moguće je korištenjem odgovarajuće klase modela matematičkog programiranja što se odnosi na modele ciljnog programiranja. Rezultati primjene navedene klase modela odnose se na adekvatno struktuiranje kvantiteta ishrane u funkciji postizanja željenog kvaliteta izlaznih performansi sistema kao cjeline.

NUTRITIVNI KAUZALITETI FUNKCIONALNE POTENTNOSTI

Ukoliko ljudski organizam posmatramo kao sistemsku kategoriju, sa aspekta opšte teorije sistema, obavezni smo uvažiti odgovarajuće činjenice, među kojima je potrebno imati u vidu, da:

- Sistem predstavlja koaliciju elemenata koji imaju za cilj da zajednički obave odgovarajuću funkciju;
- Funkcionalni zbir elemenata je uvijek veći od njihovog aritmetičkog zbira;
- Promjene na jednom elementu dovode do promjena na ostalim elementima i sistemom

organism. In addition, empirical studies confirm the fact that on one hand, a subtle balancing of nutrition facilitates an increase of the level of functional-health potency of the human organism, and on the other hand confirm many times proven fact of direct and intense causality of numerous functional imbalances in relation to the structural characteristics of nutrition.

If we understand, observe and analyze the human organism as a complex system, it is necessary to, by means of a balanced approach, structure an input vector in order to achieve desired values of output values. The research method is a mathematical modeling of the structure and functioning of the human organism in terms of optimal functioning.

Purpose, goal and efficacy of the modeling methodology are reflected in the efficacy of a researcher to construct a model which is “a true copy of the real system, i.e. original” (Landika, 2010).

It is clear that the structure of the input vector is related to the quality and quantity of nutrition, and the coordinates of the output vector are related to the performances of the human organism, i.e. psycho-physical potency and a state of health in general. A general state of health represents weight, Body Mass Index (BMI), laboratory blood analysis results, blood pressure and the results of numerous medical-laboratory analysis adjusted to the individual needs of a consumer.

Adjusting the scope and structure of nutrition to the needs and preferences of each individual consumer, along with achieving the desired output values, is possible by using appropriate classes of mathematical programming models, which is related to the models of targeted programming. The results of the mentioned model classes are related to the adequate structuring of nutrition quantity in order to achieve desired quality of output performances of the system as a whole.

NUTRITIONAL CAUSATIVES OF THE FUNCTIONAL POTENCY

If we look at the human organism as a system category, in terms of a general theory of the system, we are obliged to take into account appropriate facts, among which it is necessary to bear in mind that:

- The system represents a coalition of elements that aim to jointly perform an appropriate function;
- The functional sum of elements is always higher than their arithmetic sum;
- Changes in one element cause changes in other elements and in the system as a whole;

kao cjelinom;

- Održiv sistem mora biti orijentisan cilju, a ciljevi složeni u hijerarhijsku mrežu (Mikić, 2007).

Kvalitet se definiše kao: „Nivo do kog skup svojstvenih karakteristika proizvoda, procesa ili sistema zadovoljava zahtjeve korisnika i svih zainteresovanih strana“ (ISO 9001:2008). Polazeći od navedene definicije kvaliteta, a reflektujući se na direktan uticaj ishrane na zdravstvenu sliku stanovništva, sa jedne strane, kao i polazeći ne samo od savjesnosti pojedinaca, već uvažavajući „zahtjeve ostalih zainteresovanih strana“, sa druge strane, optimalna ishrana stanovništva treba, odnosno mora postati imperativ u funkciji postizanja i održavanja optimalne psihofizičke, radne i zdravstvene potentnosti, kako postojeće, tako i buduće ljudske populacije. Jasno je da se pod pojmom ostalih zainteresovanih strana podrazumijevaju lično i opšte okruženje pojedinaca i opšte populacije (porodica, društveni sistem, radna sredina, sistem zdravstvene njege i zaštite...).

Stanovište medicinske struke jasno ukazuje na postojanje izražene koorelacije obima i strukture ishrane, sa jedne strane i brojnih karakteristika zdravstvenog stanja, sa druge strane. Polazeći od sistemskog pristupa jasno je da je potrebno uspostaviti kolo povratne sprege između izlaza sistema odgovarajućom strukturom ulaznog vektora.

Ishrana treba da obezbjedi organizmu optimalno funkcionisanje, daje mu potrebnu energiju i hranljive materije za balans potreba, želja i mogućnosti. Ishrana nije samo energetsko – pokretačka karakteristika tehničke prirode, pored toga, posjeduje i značajnu hedonističku dimenziju koju nije lako kontrolisati.

Izbalansirana ishrana, odnosi se na obezbjeđivanje odgovarajuće energije, sadržaja hranljivih komponenti, ali bilo bi poželjno da se ne zanemari i nematerijalna dimenzija ishrane. Stručne preporuke su nedovoljno jasne, ograničene na samo uzak dijapazon komponenti ishrane, djelimično ili potpuno isključivanje određenih namirnica, neadaptivnost i nefleksibilnost stručnih preporuka.

Realizovani istraživački projekat ima za cilj i zadatak da da odgovor na pitanje da li postoji potreba za uspostavljanjem i održavanjem izbalansiranog režima ishrane i koji su faktori koji opredjeljuju korisnike u pogledu izbora postojećeg režima.

Formirana struktura uzorka istraživanja omogućava pouzdanost izvedenih zaključaka sa aspekta veličine i strukture uzorka.

Prost slučajan uzorak obuhvata 191 ispitanika različitih individualnih karakteristika, koje se odnose na

- Sustainable system must be directed towards an objective, and the objectives have to be consolidated in a hierarchical network. (Mikić, 2007)

Quality is defined as follows: Extent to which a set of inherent characteristics of a product, process or system meets the requirements of consumers and all interested parties.” (ISO 9001:2008). If we take the above stated definition as a starting point while referring to a direct influence of nutrition on a health profile of the population on one hand, as well as by starting from not only the conscientiousness of an individual but also by taking into account “the requirements of other interested parties” on the other hand, an optimal nutrition should, i.e. must become an imperative in order to achieve and maintain the optimal psycho-physical, working and health potency of both existing and future human population. It is clear that the term *other interested parties* includes personal and general environment of individuals and population in general (family, social system, working environment, health care system, etc.).

Views of medical profession clearly indicate the existence of articulated correlation of the scope and structure of nutrition on one hand, and numerous characteristics of a state of health on the other hand. Starting from a systemic approach, it is evident that it is necessary to establish a round feedback between the system output by means of appropriate structure of the input vector.

Nutrition should ensure optimal functioning of the organism, providing it with necessary energy and nutrients for the balance of needs, desires and possibilities. Nutrition is not just an energetic-driving characteristic of technical nature; in addition to that, it also possesses a significant hedonistic dimension which is not easy to control.

Balanced nutrition refers to providing appropriate energy, content of nutrients, and it would be advisable not to neglect a non-material dimension of nutrition. Professional recommendations are not clear enough, and are limited only to a narrow diapason of diet components, partial or complete exclusion of certain ingredients, non-adaptiveness and inflexibility of professional recommendations.

Realized research project has as an objective and task to answer the question whether there is a need for establishing and maintaining balanced diet regime and which factors have influence on consumers in terms of existing regimes.

Formed structure of research samples facilitates the reliability of derived conclusions in terms of the sample size and structure.

A simple random sample includes 191 examinees

starost, pol, obrazovanje i mjesto stanovanja. Starosnu strukturu ispitanika moguće je prikazati sljedećim tabelarnim prikazom:

Tabela 1. Starosna struktura ispitanika

| Starost ispitanika / Examinee age | Broj ispitanika / Number of examinees | Udio ispitanika / Share of examinees |
|--|---------------------------------------|--------------------------------------|
| Do 20 godina / Up to 20 years | 77 | 40,31% |
| 20 – 30 godina / years | 18 | 9,43% |
| 30 – 40 godina / years | 76 | 39,79% |
| 40 – 50 godina / years | 14 | 7,33% |
| Više od 50 godina / More than 50 years | 6 | 3,14% |
| Ukupno / Total | 191 | 100,00% |

with different individual characteristics related to the age, gender, education and place of residence. Age structure is shown in the Table below:

Table 1. Examinee age structure

Strukturu ispitanika prema polu moguće je prikazati sljedećim tabelarnim prikazom:

Tabela 2. Struktura ispitanika prema polu

| Pol ispitanika / Examinee gender | Broj ispitanika / Number of examinees | Udio ispitanika / Share of examinees |
|----------------------------------|---------------------------------------|--------------------------------------|
| Muški / Male | 63 | 33% |
| Ženski / Female | 128 | 67% |
| Ukupno / Total | 191 | 100,00% |

Examinee gender structure is shown in the Table below:

Table 2. Examinee gender structure

Obrazovna struktura ispitanika može se prikazati sljedećim tabelarnim prikazom:

Tabela 3. Obrazovna struktura ispitanika

| Stručna sprema ispitanika / Examinee professional qualification | Broj ispitanika / Number of examinees | Udio ispitanika / Share of examinees |
|--|---------------------------------------|--------------------------------------|
| Sss (srednja stručna sprema) / High School Diploma | 82 | 43% |
| Vš (završena viša škola) / College Degree | 35 | 18% |
| Vss (visoka stručna sprema) / Bachelor Degree | 68 | 36% |
| Mr i dr (naučni stepen magistra i doktora nauka) / Master/PhD Degree | 6 | 3% |
| Ukupno / Total | 191 | 100,00% |

Examinee education structure is shown in the Table below:

Table 3. Examinee education structure

Podaci za potrebe ispitivanja prikupljeni su telefonsko – elektronskim anketiranjem ispitanika, gdje su stavovi ispitanika provjeravani sljedećim upitnikom:

Data for the research purposes are collected by questioning examinees over the phone or by electronic means, where the following questionnaire was used to test the attitudes of examinees:

Tabela 4. Mišljenje ispitanika u pogledu individualnih prehrambenih navika

Table 4. Opinion of the respondents in terms of individual eating habits

| Redni broj / No. | Pitanje / Question | Ponuđeni odgovori / Possible answers | Dobijeni odgovori / Answers obtained | |
|------------------|--|---|---------------------------------------|--------------------------------------|
| | | | Broj ispitanika / Number of examinees | Udio ispitanika / Share of examinees |
| 1. | Ocijenite kvalitet Vaše ishrane: / Evaluate the quality of your nutrition: | Loša (nezdrava) / Poor (unhealthy) | 177 | 92,7% |
| | | Većinom nezdrava / Mostly unhealthy | 3 | 1,6% |
| | | Umjereno zdrava / Moderately healthy | 5 | 2,6% |
| | | Većinom zdrava / Mostly healthy | 1 | 0,5% |
| | | Zdrava (potpuno) / Healthy (completely) | 5 | 2,6% |
| Ukupno / Total: | | | 191 | 100% |
| 2. | Zašto se ne hranite zdravo za (ispitanike koji su na pitanje broj 1 ponudili odgovore 1 ili 2): / Why do you eat unhealthy food (for examinees who answered the question 1 with the answers 1 or 2): | Novac (zdrava hrana je skuplja) / Money (healthy food is more expensive) | 4 | 2,1% |
| | | Vrijeme (potrebno za spremanje i/ili konzumaciju) / Time (necessary for preparation and/or consumption) | 54 | 30,0% |
| | | Nejasni zahtjevi (neprecizna uputstva) / Unclear requirements (unclear instructions) | 57 | 31,7% |
| | | Ukus (zdrava hrana nije ukusna) / Taste (healthy food is not tasty) | 28 | 15,6% |
| | | Ništa od navedenog / None of the stated | 37 | 20,6% |
| Ukupno / Total: | | | 180 | 100% |
| 3. | Da li ste imali iskustvo sa (da li ste proživjeli): / Have you had any experience with (whether you have experienced): | Trudnoću / Pregnancy | 46 | 24,1% |
| | | Bolest (oboljenje) koje je zahtijevalo promjenu režima ishrane / Disease (illness) that required a change of diet | 109 | 57,1% |
| | | Ništa od navedenog / None of the stated | 36 | 18,8% |
| Ukupno / Total: | | | 191 | 100% |
| 4. | Smatrate li da trebate promijeniti režim ishrane: / Do you think you should change your diet: | Da / Yes | 139 | 73% |
| | | Ne / No | 52 | 27% |
| Ukupno / Total: | | | 191 | 100% |
| 5. | Ako da, zašto: / If yes, why: | Trudnoća/solidarnost sa bliskom osobom/briga za blisku osobu / Pregnancy/solidarity to a person close to you/care for a person close to you | 44 | 31,6% |
| | | Bolest (sprečavanje bolesti) / Disease (prevention of disease) | 66 | 47,5% |
| | | Potreba/želja za zdravim životom / Need/desire for a healthy life | 4 | 2,9% |
| | | Društvena afirmacija / Social affirmation | 13 | 9,4% |
| | | Ništa od navedenog / None of the stated | 12 | 8,6% |
| Ukupno / Total: | | | 139 | 100% |

Analizom dobijenih rezultata lako je zaključiti da je svijest ispitanika u pogledu kvaliteta ishrane visoka, jer čak 94,3% ispitanika smatra da im ishrana nije zdrava, 73% ispitanika smatra da treba promijeniti ishranu a među njima 79,1% iz zdravstvenih razloga (briga za vlastiti i/ili zdravlje bliske osobe), a čak 57,1 % ispitanika iskusi je promjenu režima ishrane iz zdravstvenih razloga.

CILJNO PROGRAMIRANJE KAO OKOSNICA BALANSIRANJA KVALITETA I KVANTITETA ISHRANE

Struktura ishrane, sa jedne strane, podrazumijeva odgovarajuće tehničke karakteristike kao što su količine pojedinih hranljivih materija sadržanih u njoj. Navedeno se odnosi na preporučeni dnevni unos RDA (engl. recommended daily allowance) pojedinih komponenti, kao čisto tehničko pitanje. Sa druge strane, ishrana ima društvenu, socijalnu, hedonističku i brojne druge nemjerljive dimenzije.

From the analysis of the results obtained it is easy to conclude that the awareness of examinees in terms of nutrition quality is high since 94.3% of examinees believe their diet is unhealthy, 73% believe they should change their diet, and among them 79.1% think they should change their diet due to health issues (care for own health and/or the health of a person close to them), and 57.1% of examinees have experienced change in diet due to health issues.

TARGETED PROGRAMMING AS A BACKBONE OF BALANCING THE QUALITY AND QUANTITY OF NUTRITION

On one hand, the nutrition structure implies appropriate technical characteristics such as the quantity of certain nutrients contained in it. The above stated relates to a recommended input of RDA (recommended daily allowance) of certain components, simply as a technical issue. On the other hand, nutrition has a social, hedonistic and numerous others immeasurable dimensions.

Ukoliko analiziramo rezultate proizašle iz provedenog istraživanja, zaključujemo da u najvećoj mjeri u pogledu primjene nezdrave ishrane ispitanike ograničavaju vrijeme (30%) i nedovoljno znanje (31,7%), slijedi nezadovoljstvo ukusom zdrave hrane (15,6%), a najmanji stepen uticaja imaju troškovi zdrave ishrane (samo 2,1% ispitanika novac ograničava u priklanjanju zdravoj ishrani).

Ukoliko bi se uspostavljanje optimalnog režima ishrane učinilo dostupnijim, prepoznatljivijim širem stepenu korisnika i pretendenta, bilo bi opravdano očekivati da bi se značajan broj priklonio zdravijem opredjeljenju.

Uspostavljanjem optimalnog režima ishrane moguće je da se programskim putem izbalansiraju ukusi, želje i lične preferencije sa potrebama i zahtjevima uspostavljenih standarda ishrane. (Napomena: Standard je precizno definisan zahtjev kojeg mora da ispuni izlaz iz nekog sistema ili sam sistem (ISO 9001:2008))

Modeli ciljnog programiranja imaju zadatak da programiraju obim i strukturu aktivnosti sistema kako bi se omogućilo istovremeno ostvarivanje većeg broja postavljenih ciljeva. Opšti oblik modela ciljnog programiranja glasi:

a) Funkcija cilja:

$$(\min); z = \sum_{j=1}^m c_j d_j^+ + \sum_{j=1}^m c_{j+m} d_j^- \quad (1)$$

b) Sistem ograničenja: $A \cdot \vec{X} \geq \vec{A}_0$ (2)

c) Uslovi, pretpostavke primjene modela:

$$\vec{X} \geq \vec{0}; d_j^+ \cdot d_j^- = 0 \quad (3)$$

Gdje su:

\vec{X} - vektor aktivnosti, u kontekstu potreba programiranja optimalnog programa ishrane koordinate vektora aktivnosti odnose se na kvantitet učešća pojedinih namirnica u strukturi programirane funkcionalne ishrane;

A – matrica tehnologije, u kontekstu potreba programiranja optimalnog programa ishrane koordinate matrice tehnologije odnose se na sadržaj pojedinih hranjivih materija u odgovarajućim namirnicama;

\vec{A}_0 - vektor kapaciteta, u kontekstu potreba programiranja optimalnog programa ishrane koordinate vektora kapaciteta odnose se na ciljani unos pojedine hranjive materije u funkcionalnoj ishrani;

d_j^+ - devijaciona promjenljiva u modelu ciljnog programiranja koja označava prebačaj j – tog cilja, u kontekstu programiranja optimalnog programa ishrane devijaciona promjenljiva označava unos j – te hranjive materije iznad ciljanog nivoa;

d_j^- - devijaciona promjenljiva u modelu ciljnog programiranja koja označava podbačaj j – tog cilja, u kontekstu

If we analyze the results derived from the research conducted, we come to a conclusion that, in terms of unhealthy food usage, examinees are limited by time (30%) and insufficient knowledge (31.7%), the next is dissatisfaction with the taste of food (15.6%), and the least degree of influence have costs of healthy food (only 2% of examinees are limited by money in choosing a healthy diet).

If the establishment of an optimal diet regime is made more available, recognizable to a wider range of users and pretenders, it would be justified to expect that a significant number of them would choose a healthy diet.

The establishment of the optimal diet regime is possible if a program is used to balance tastes, desires and personal preferences with the needs and requirements of the established diet standards. (Note: Standard is a precisely defined requirement which must be met by an output of a system or by the system itself (ISO 9001:2008)).

Models of targeted programming have a task to program the scope and structure of the system activities in order to simultaneously facilitate the achievement of a larger number of set objectives. The general form of the targeted programming model is as follows:

a) Objective function:

$$(\min); z = \sum_{j=1}^m c_j d_j^+ + \sum_{j=1}^m c_{j+m} d_j^- \quad (1)$$

b) Limitation system: $A \cdot \vec{X} \geq \vec{A}_0$ (2)

c) Conditions, model implementation assumptions:

$$\vec{X} \geq \vec{0}; d_j^+ \cdot d_j^- = 0 \quad (3)$$

Where:

\vec{X} - is a vector of activity, in the context of the needs for programming an optimal diet program, coordinates of the vector activities relate to the quantity of share of certain nutrients in the structure of programmed diet;

A – technology matrix, in the context of the needs for programming an optimal diet program, coordinates of the technology matrix relate to the content of certain nutrients in appropriate ingredients;

\vec{A}_0 - capacity vector, in the context of the needs for programming an optimal diet program, coordinates of the capacity vector relate to the targeted input of nutrients in functional diet;

d_j^+ - deviating variable in the model of targeted programming representing an overperformance of the j – objective, in the context of programming of an optimal diet program, deviating variable represents the input of j – nutrient above the targeted level;

d_j^- - deviating variable in the model of targeted programming representing an underperformance of the j – objective, in the context of programming of an optimal diet

programiranja optimalnog programa ishrane devijaciona promjenljiva označava unos j – te hranjive materije ispod ciljanog nivoa.

Uslovi koje se odnose na promjenljive u modelu ukazuju na činjenicu da količine pojedinih komponenti ishrane ne mogu (ne smiju) imati negativnu vrijednost. Pored toga, važno je naglasiti da se u pogledu ostvarivanja pojedinih ciljeva, ciljanu vrijednost nije moguće istovremeno podbaciti i prebaciti.

Optimalno rješenje modela je onaj vektor X koji zadovoljava sistem ograničenja, postavljene uslove i za koje funkcija cilja postiže željenu ekstremnu vrijednost, (Landika, 2008).

U kontekstu optimizacije izbalansirane ishrane važno je naglasiti da postoji mogućnost da se podbačaji, odnosno prebačaji odgovarajućih ciljeva onemogućuje, uvođenjem odgovarajućih pondera uz devijacione promjenljive u funkciji cilja matematičkog modela (Petrić, 1981).

ZAKLJUČAK

Uspostavljanje i održavanje potentnosti ljudske populacije u visokom stepenu korelira kvalitetom ishrane u sistemskoj povezanosti pomenutih kategorija. Uspostaviti balans između uspostavljanja ulaznih vrijednosti prema zahtjevima izlaza, zahtjeva suptilno balansiranje želja i potreba korisnika informacija.

Briga o zdravlju i ishrani koja omogućava uspostavljanje i održavanje njegovog potrebnog nivoa zahtjeva formiranje adekvatnih modela matematičkog programiranja, čiji rezultati će kvalitet ishrane da prilagode željama i ukusima korisnika.

Predložena aplikacija svakako ima dovoljno veliko potencijalno tržište primjene. Prednosti korištenja modeliranih informacija omogućavaju:

- Kvantitativno, a ne kvalitativno ograničavanje konzumacije;
- Prilagođavanje kvaliteta ishrane individualnim zahtjevima;
- Istovremeno uvažavanje većeg broja različitih zahtjeva (kalorijska vrijednost, sadržaj i potrebe pojedinih hranljivih komponenata...);
- Direktan i kompletan uvid u odstupanja i posljedice od odstupanja od ciljanih veličina;
- Upravljanje troškovima izbalansirane ishrane.

Dostupnost rezultata modeliranja zahtjeva određena ulaganja koja se odnose na izradu odgovarajućeg matematičkog modela i njegovu komercijalizaciju putem elektronskih medija, ali svakako koristi proizašle od njegove eksploatacije, prevazilaze troškove.

program, deviating variable represents the input of j – nutrient below the targeted level.

The conditions related to the variables in the model indicate that the quantities of certain diet components cannot (must not) have a negative value. In addition, it is important to emphasize that, in terms of achieving certain objectives, the targeted value cannot be simultaneously overperformed or underperformed.

An optimal model solution is the vector X which satisfies the limitation system, set conditions and for which, the objective function achieves a desired extreme value.

In the context of optimization of the balanced diet, it is important to emphasize that there is a possibility that the overperformances, i.e. underperformances of appropriate objectives can be disabled by introducing appropriate weights along with the deviating variables in the function of the mathematical model objective. (Petrić, 1981).

CONCLUSION

Establishing and maintaining of the potency of the human population on a high level correlates with the quality of nutrition in the systemic connectedness of the stated categories. To establish a balance between the establishment of input values, in relation to output requirements, requires a subtle balancing of desires and needs of information users.

Care for health and diet which facilitates the establishment and maintenance of their necessary level requires forming of adequate models of mathematical programming whose results will adjust the quality of diet to the desires and taste of consumers.

Of course, a proposed application has a large enough potential market of implementation. The advantages of using modeled information facilitate:

- Quantitative and not qualitative limitation of consumption;
- Adjustment of diet quality to individual requirements;
- Simultaneously taking into account a larger number of different requirements (caloric value, the content and needs of certain nutrient components, etc.);
- A direct and complete insight in deviations and consequences of deviations in targeted values;
- Managing the costs of balanced diet.

The availability of the results of modeling requires certain investments related to the design of appropriate mathematical model and its commercialization by means of electronic media, however benefits derived from its exploitation exceed the costs.

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ANALIZA INTENZITETA OPTEREĆENJA I POTROŠNJE ENERGIJE KOD PLESAČA REKREATIVACA

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Apstrakt: Učestvovanje u sportskoj rekreaciji postaje sve važnije kako ista ima veliki uticaj na kvalitet ljudskog života; poboljšavajući i opšte zdravlje i fizičko stanje. Ples se ne posmatra samo kao profesionalni sport, nego je među ljudima stekao i značajnu popularnost kao vrsta rekreacije. Istraživanje je sprovedeno na 93 kandidata koji pohađaju časove rekreativnog plesa sa ciljem da se otkrije kakva je intenzivnost fizičkog opterećenja i potrošnje energije kod plesača. Podaci prikupljeni uz pomoć Polar Team2 sistema su korišćeni za direktno poređenje razlika u intenzitetu fizičkog opterećenja i potrošnje energije između suprotnih polova.

Razlike između intenziteta fizičkog opterećenja i potrošnje energije su određene uz pomoć ANOVA metoda. Ukratko, rezultati su pokazali da su statistički značajne razlike najočiglednije u potrošnji energije, između muških i ženskih plesača. Razlike u intenzitetu fizičkog opterećenja između polova nisu pokazale nikakav statistički značaj.

Ključne riječi: ples, rekreativni ples, društveni ples, intenzitet fizičkog opterećenja, potrošnja energije.

Uvod

Potreba za aktivnim provođenjem slobodnog vremena i potreba za bavljenjem rekreativnim aktivnostima su karakteristike stila života savremenog čovjeka, bez obzira na starosnu dob. Štaviše, ljekari su počeli propisivati kretanje za preventivno djelovanje na bolesti čovjeka, ali i za liječenje. Sve veći broj nalaza stručnjaka idu u prilog ideji da se, uprkos, starosti može zadržati visok kvalitet života, da se ostane fleksibilan, pokretljiv i vitak. Redovan fizički angažman i uključenost u rekreativno bavljenje sportom se svrstavaju u jednu od najvažnijih komponenti zdravog načina života odraslih ljudi. Odsustvo ili nedostatak fizičke aktivnosti dovodi do mnogih

THE INTENSITY OF THE PHYSICAL LOAD AND ENERGY EXPENDITURE ANALYSIS OF PARTICIPANTS OF RECREATIONAL DANCING

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Abstract: Engagement in sport recreation is becoming more and more valuable, as it has big impact on people's quality of life; improving both, general health and physical condition. Dancing is not only seen as a professional sport, but it has been gaining significant popularity among people as type of recreation as well. With an aim to find out what intensity of the physical load and energy expenditure represent to its participants, a study based on a sample of 93 candidates of recreational dance classes, has been carried out. Data obtained with the help of the system Polar Team2 was used for direct comparison of differences in intensity of the physical load and energy expenditure between opposite genders.

Differences between the intensity of the physical load and energy expenditure were determined using ANOVA. In summary, results have shown that statistically significant differences were most apparent in energy expenditure between male and female dancers. Differences in the intensity of the physical load between genders did not show any statistical significance.

Key words: dance, recreational dance, social dance, intensity of the physical load, energy expenditure.

INTRODUCTION

The need for having an active leisure time and for practicing recreational activities mark the lifestyle of a modern man, regardless of his/her age. What is more, physicians have started prescribing movement both for prevention of diseases and as a treatment. There are more and more expert reports that support the idea that even in the old age one can maintain high quality of life, flexibility, mobility and a good shape. Regular physical exercise and engagement in recreational sport are deemed to be some of the most important components of adults' healthy lifestyle. The absence or lack of physical activity leads to many degenerative diseases, damage of vital

degenerativnih bolesti, oštećenja vitalnih funkcija i pre-ranog starenja.

Istraživanja su pokazala da ples blagotvorno djeluje na fiziološke, kao i na psihološke sposobnosti i svojstva (Hopkins, Murrah, Hoeger & Rodes, 1990). Za razliku od vježbanja u zatvorenom prostoru na biciklu i trenažera, koji razvijaju uglavnom donji dio tijela, mnogim plesnim aktivnostima može se trenirati cijelo tijelo, a takav trening ima pozitivan uticaj na tonus mišića, kao i aerobne karakteristike pojedinca (Alpert, 2011). Osim uticaja na fiziološke sposobnosti, kreativno izražavanje, poboljšanje socijalizacije i zabave, istraživači su otkrili da ples ima pozitivan uticaj na podizanje raspoloženja, samopouzdanje, blagostanje i povećanje međuljudskih kontakata između odraslih žena (Blackman, Hunter, Hilyer & Harrison, 1988; Estivill, 1995).

Rezultati pokazuju da je ples je odličan oblik tjelesne aktivnosti, u koju se djeca rado uključuju, a posredno utiče na njihovo zdravlje i fizičko stanje (Ignico i Mahon, 1995; Kremenitzer, 1990), na kognitivni i emocionalni razvoj (Brodie i Birtwistle, 1990), a naravno i na razvoj motoričkih sposobnosti. Rani kontakt djece sa plesom indirektno daje dobru osnovu za buduće rekreativno bavljenje različitim plesnim formama.

Proces starenja ima značajan uticaj na promjene u sastavu tijela i psihofizičke karakteristike pojedinca. Starije osobe imaju značajno veći postotak masnog tkiva, smanjenu vrijednosti mišićne mase (Fiatarone-Singh, 2002), smanjenu snagu i izdržljivost mišića (Harridge, Magnusson i Saltin, 1997), lošu ravnotežu (Hsiao-Weckler i Robinovitch, 2007) i smanjenu aerobnu sposobnost (Harridge et al., 1997) u poređenju sa mladima. Dokazano je da plesna rekreativna vježba može kod starijih uveliko poboljšati njihove aerobne sposobnosti, izdržljivost donjeg dijela tijela, snagu i fleksibilnost, ravnotežu i da podstiče nivo fizičke aktivnosti. Bavljenje plesom poboljšava psihičko/mentalno zdravlje pojedinca, djeluje opuštajuće, podstiče samopouzdanje i koordinaciju između mozga i tijela (Keogh, Kilding, Pidgeon, Ashley i Gillis, 2009).

Mjerenje srčanih otkucaja se sve više koristi u različitim sportskim granama i aktivnostima. Brojanje otkucaja srca postaje važna pomoć u okviru kondicione pripreme. Omogućava bolju kontrolu, pravilno doziranje opterećenja i poboljšanje efikasnosti treninga, a posebno, kada je u pitanju trening osnovne i specijalne izdržljivosti (Bračić & Bon, 2010).

Osnovni cilj istraživanja je da se utvrdi postojanje razlike u intenzitetu opterećenja i potrošnji energije kod plesača rekreativnog plesa.

functions and premature aging.

Researches have shown that dancing has a positive effect on physiological as well as psychological abilities and attributes (Hopkins, Murrah, Hoeger & Rodes, 1990). Unlike exercising in closed spaces on stationary bicycles and treadmills which mostly develop the lower part of the body, many dance activities can train the whole body, and such training has a positive effect on muscle tone as well as on aerobic characteristics of a person (Alpert, 2011). Apart from the influence on physiological abilities, creative expression, improvement of socialization and pastime, researchers have discovered that dance has a positive effect on mood, self-esteem, well-being and the increase of interpersonal relations among adult women (Blackman, Hunter, Hilyer & Harrison, 1988; Estivill, 1995).

The results have shown that dancing is an excellent form of physical activity in which children gladly participate, and it indirectly impacts their health and physical condition (Ignico & Mahon, 1995; Kremenitzer, 1990), their cognitive and emotional development (Brodie & Birtwistle, 1990), and of course, development of motor skills. Children's early exposure to dancing gives them a good basis for the future recreational engagement in different dance forms.

The aging process has a significant influence on changes in the body composition and psychophysical characteristics of an individual. Older persons have significantly higher percentage of body fat, decreased muscle mass value (Fiatarone-Singh, 2002), decreased muscle strength and endurance (Harridge, Magnusson & Saltin, 1997), poor balance (Hsiao-Weckler & Robinovitch, 2007) and lower aerobic ability (Harridge et al., 1997) as compared to the young. It has been proven that recreational exercising through dance can greatly improve older people's aerobic abilities, endurance of the lower part of the body, strength and flexibility, balance and that it increases the level of physical activity. Dancing improves psychological/mental health of an individual, it is relaxing, and it boosts self-confidence and coordination between the brain and the body (Keogh, Kilding, Pidgeon, Ashley & Gillis, 2009).

Heart rate measuring is increasingly used in different sport branches and activities. The heart rate measuring has become an important aid in training. It enables better control, correct dosing of the physical load, and improvement of the training effectiveness (Bračić & Bon, 2010).

The main goal of the research has been to determine the existence of a statistically significant difference in the intensity of the physical load and energy expenditure among dancers of recreational dance.

METOD RADA

Uzorak ispitanika

Uzorak predstavlja 93 ispitanika oba pola (46 muških i 47 ženskih). Prosječna starost ispitanika muškog pola je 49,9 godina, ženskog pola 46,7 godina, a prosječna starost cijele grupe ispitanika je 48,3 godina. Ispitanici su pohađali tzv. plesno veće društvenog plesa, koje uključuje 8 plesova (valcer, ča ča ča, disco hustle, samba, džajv, bečki valcer, brzi fokstrot, blues), a prisustvovali su na časovima u plesnoj školi jednom sedmično.

Uzorak varijabli

U ovom istraživanju varijable su bile: intenzitet opterećenja (srčana frekvencija, otk/min) i potrošnja energije (kcal). Svaka od njih je dobijena ili izračunata posebno za svakog ispitanika.

Opis istraživanja

Istraživanje je provedeno u tri plesne škole u Sloveniji, jednoj u Novoj Gorici, drugoj u Ljubljani i trećoj u Slovenj Gradecu. Dakle, istraživanje je sprovedeno među ispitanicima, koji su se bavili istom vrstom plesa, plesali na istu muziku s istim tempom, ali pod okriljem raznih učitelja. Svaki nastavnik je po slobodnom izboru odabrao različite korake i koreografije i to je jedina varijabla koja je mogla biti ista na svim mjestima. Koreografija po sebi može uticati na intenzitet plesanja, ali uprkos različitim koracima, kada je u pitanju rekreativni nivo plesa, može se ustvrditi da ne postoje velike razlike u intenzitetu vježbanja.

Kako bi se osigurali što približniji uslovi kod ispitanika iz različitih mjesta u Sloveniji unaprijed je pripremljena muzika, na koju su plesali ispitanici. Išlo se od jednostavnih ka složenijim plesovima. Počelo se sa engleskim valcerom, nastavilo sa bluzom, ča ča ča, bečkim valcerom, disco hustlom, sambom i brzim fokstrotom. Dužina muzike je 2 minuta i 30 sekundi. CD je snimljen tako da ste uvijek išla dva ista plesa zaredom, prvi ples je išao sporijim tempom, a drugi bržim tempom izvođenja. Pauza između plesova iznosila je deset sekundi. Prije početka testiranja, ispitanici su popunili upitnik sa sljedećim podacima: ime i prezime, datum rođenja, pol, tjelesna težina, tjelesna visina, vrsta plesne rekreacije i redovnost vježbanja i eventualne zdravstvene tegobe (na osnovu čega je zaključeno da li su svi ispitanici bili zdravi).

Mjerenje je vršeno na redovnim treninzima plesa. Svaki trening se sastojao od 20 minuta pripremnog dijela, 60 minuta rekreativnog vježbanja sa pauzama

METHOD

Research sample

The research sample consisted of 93 participants of both sexes (46 males and 47 females). The average age for males was 49.9 years and for females was 46.7 years, while the average age for the whole group was 48.3 years. The participants attended so called dance evening of social dance which included 8 dances (waltz, cha cha cha, disco hustle, samba, jive, Viennese waltz, quickstep, and blues), and they also attended dance school classes once a week.

Variables sampling

In this research the variables have been: the intensity of the physical load (heart rate, beat/min) and energy expenditure (kcal). Each of these has been gotten or calculated separately for each participant.

Research description

The research has been carried out in three dance schools in Slovenia; one is in Nova Gorica, another in Ljubljana, and the third one in Slovenj Gradec. Therefore, the research has been carried out among participants who train the same kind of dance, dance to the same music with the same rhythm, but who are under the guidance of different coaches. Each coach has freely chosen different steps and choreographies and that is one variable that could not be the same among the schools. Choreography in itself can influence the intensity of dancing; however, in spite of different dance steps, and in regards to the recreational level of dancing, it can be affirmed that there are no big differences in the intensity of exercising.

In order to ensure as similar conditions as possible for the participants in different places of Slovenia, the music that participants danced to was prepared in advance. They started with easier dances moving toward more complex dances. The opening dance was English waltz, followed by blues, cha cha cha, Viennese waltz, disco hustle, samba and quickstep. The duration of music was 2 minutes and 30 seconds. The CD was recorded so that there was a sequence of two of the same dances in a row: the first dance had a slower rhythm while the second dance had a faster rhythm. The break between dances was ten seconds. Before the start of testing, the participants had filled in a questionnaire with the following data: first and last name, date of birth, sex, body weight, body height, the type of dance recreation and frequency of exercising, and possible health problems (on which basis was concluded that all the participants were healthy).

Measuring took place during regular training sessions. Each training session consisted of 20 minutes of prepara-

od 10 sekundi između pojedinih plesova i na kraju 15 minuta opuštanja. Na taj način je obezbjeđen visok intenzitet vježbanja, prema kojem se svaki ispitanik prilagođavao, shodno sopstvenim mogućnostima i sposobnostima.

Ispitanici su mjereni sistemom Polar Team2, gdje su podaci prikupljeni u realnom vremenu na centralnom računaru, a svaki od plesača je imao svoj mjerač otkucaja srca. Sistem je zasnovan na principu telemetrije. Jak odašiljač, koji je smješten na odgovarajućem pojasi, prenosi podatke o vrijednosti srčane frekvencije do stacioniranog prijemnika (antene), putem bluetooth tehnologije, pri čemu je maksimalan doomet antene 100 metara. Takođe, je prije početka mjerenja u računaru određeno pet zona srčane frekvencije: 0-60%, 60-70%, 70-80%, 80-90% i 90-100% od maksimalnih otkucaja. Osim prosječnih vrijednosti otkucaja srca u istraživanju bilo je značajno utvrditi koliko su energetske zahtjevni rekreativni časovi plesa i koliko su vježbači aktivni sa energetskog stanovišta. Za mjerenje potrošnje energije, izražene u kcal, korišten je takođe Polar Team2 sistem, koji je jedan od najpreciznijih instrumenata kalorijske potrošnje na tržištu. Izračunati broj kalorija se zasniva na parametrima tjelesne težine, visine, dobi, pola, maksimalnog broja otkucaja srca i intenziteta vježbanja. Polar Team2 sistem za svakog pojedinca nakon završetka vježbanja računa broj kalorija, ovisno o unesenim varijablama. Dobijeni rezultati su korišteni za upoređivanje potrošnje energije kod obje grupe ispitanika (muški i ženski).

Metode obrade podataka

Za statističku analizu korišten je statistički paket SPSS. Za potrebe istraživanja, izračunate su aritmetička sredina i standardno odstupanje za obje varijable posebno kod muških i posebno kod ženskih ispitanika i primijenjena je univarijantna analiza varijanse (ANOVA), kako bi se utvrdilo jesu li razlike koje se javljaju između različitih varijabli statistički značajne ili ne.

REZULTATI I DISKUSIJA

Po završenom mjerenju dobijeni su sljedeći podaci: prosječna vrijednost srčane frekvence kod svih ispitanika, maksimalan broj otkucaja srca za svakog ispitanika, broj otkucaja srca tokom vježbanja za svakog ispitanika izražen u procentima i potrošnju energije u toku treninga.

Važan faktor za izračunavanje i upoređivanje intenziteta opterećenja plesača predstavlja prosječan broj otkucaja srca tokom trenazne jedinice. Polar Team 2 sistem šalje podatke prijemniku o trenutnom broju otkucaja srca

60 minutes of recreational exercising with 10 second breaks between specific dances, and in the end there was a 15 minute relaxation period. This was to ensure the high intensity of exercising and each participant adjusted himself/herself to it according to their own abilities and skills.

The participants were measured with the Polar Team2 system, with the data being collected in the real time on the central computer, and each dancer had his/her own device for measuring heart rate. The system is based on the principle of telemetry. A strong transmitter, which was placed at the appropriate belt, was transmitting the data regarding the heart rate value to the stationary receiver (antenna) via Bluetooth technology, with the maximum range of the antenna being 100 meters. Additionally, before the start of measuring, five heart rate zones were set in a computer: 0-60%, 60-70%, 70-80%, 80-90% and 90-100% of a maximum heart rate. Apart from the average heart rate values, it was important to determine how demanding were the recreational dancing classes and how active were the participants in terms of energy. The Polar Team2 system, one of the most precise instruments for measuring burned calories on the market, was also utilized for measuring the energy expenditure expressed in kcal. The number of calculated calories is based on these parameters: body weight, height, age, sex, maximum heart rate and intensity of exercising. The Polar Team2 system counted calories for each individual after the training session depending on the entered variables. The results were used for a comparison of the energy expenditure in both groups of participants (males and females).

Methodology of data analysis

A software package SPSS was used for the statistical analysis. For the research purposes, the arithmetic mean and standard deviation for both variables was calculated separately for male and female participants and univariate analysis of variance (ANOVA) was applied, so as to determine whether the differences that appear among different variables are statistically significant.

RESULTS AND DISCUSSION

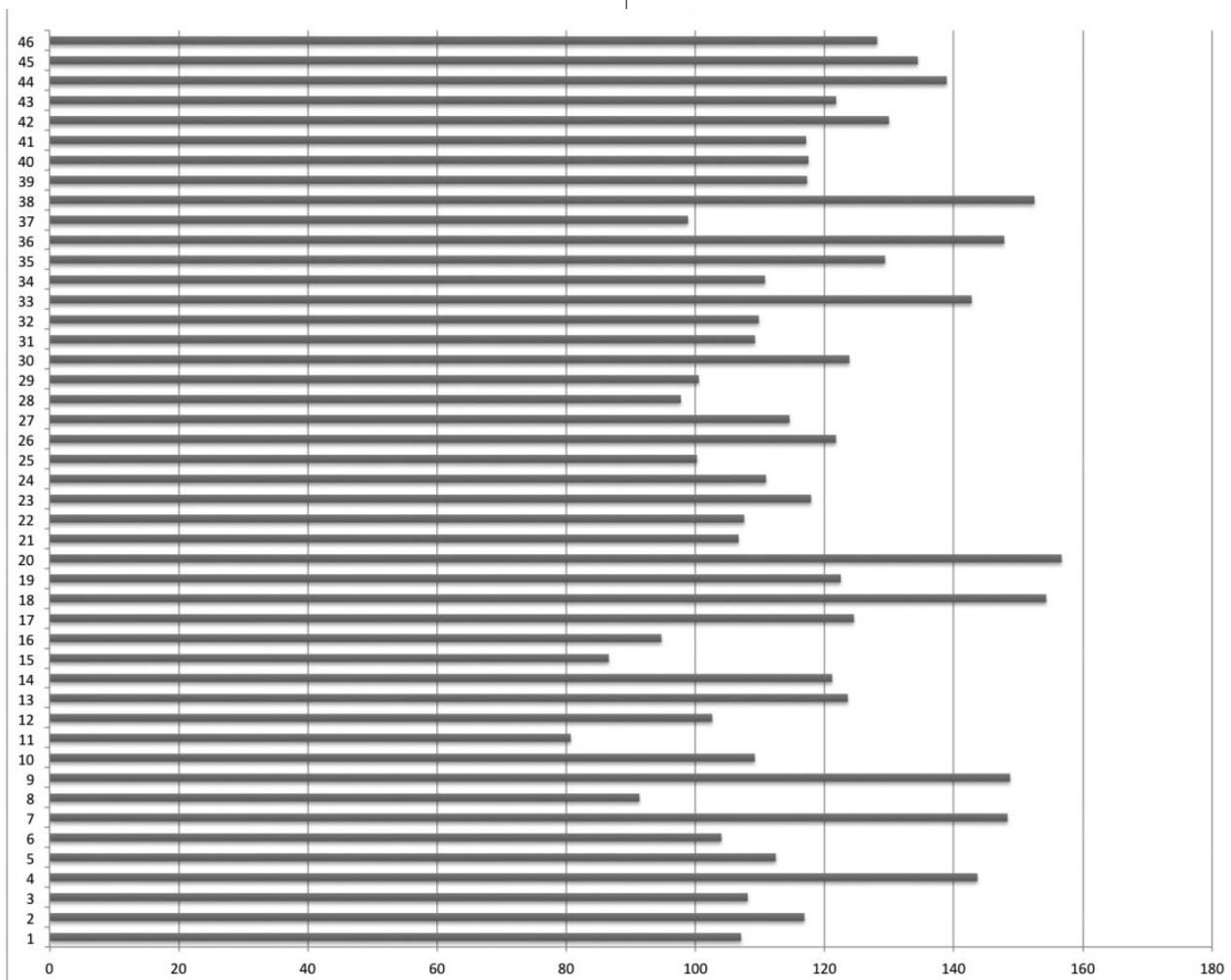
After measuring, the following data were collected: the average value of heart rate in all participants, the maximum heart rate for each participant, the number of heartbeats during exercising for each participant expressed in percentages and energy expenditure during a training session.

The important factor for calculation and comparison of intensity of the physical load among dancers is the average number of heartbeats per one training unit.

svake sekunde, tako da se u ovom istraživanju, mjerenjem dobilo 3600 podataka o trenutnom broju otkucaja srca. Zbog tako velikog broja dobijenih podataka, prosječni broj otkucaja srca tokom vježbanja je vrlo dobro definisan.

Dobijeni podaci pokazuju da postignute maksimalne postignute vrijednosti otkucaja srca nisu povezane sa radnim opterećenjem. Uprkos različitim individualnim vrijednostima maksimalnog broja otkucaja srca za muškarce i žene, prosječni broj otkucaja srca je u priličnoj mjeri sličan. Muškarci su u prosjeku imali vrijednosti 119 otkucaja u minuti ($118,8 \pm 18,9$), a žene 121 otkucaj u minuti ($120,9 \pm 15,2$). Gledano u cjelini, prosječne vrijednosti otkucaja srca praktično se ne razlikuju. Navedene vrijednosti su grafički predstavljene (grafikon 1 i grafikon 2).

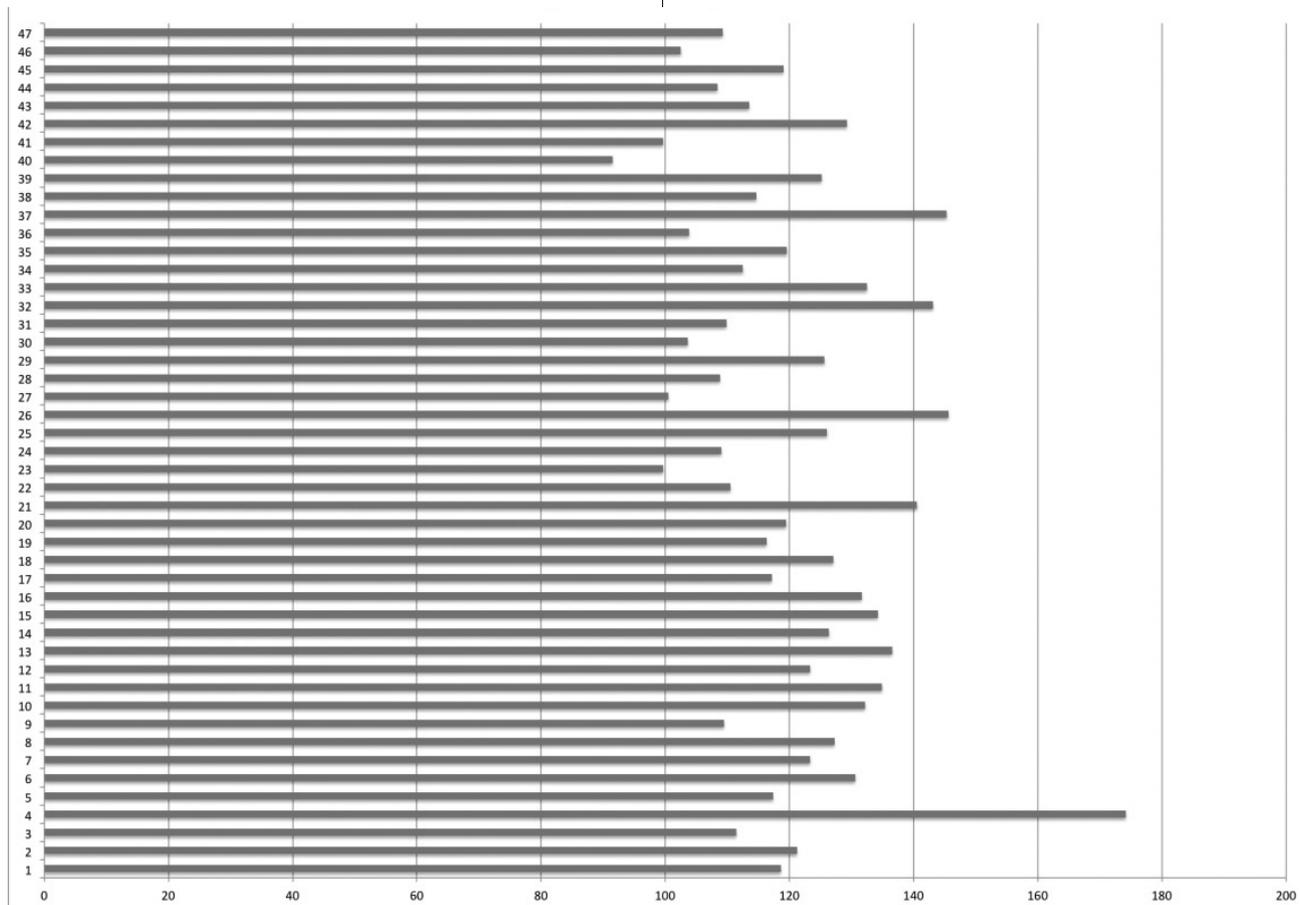
Grafikon 1. Prosječni broj otkucaja srca svakog pojedinca - plesači



The Polar Team2 system sends data to the receiver about the current number of heartbeats every second; therefore, this research resulted in 3600 data about the current heartbeats. Due to the large amount of data, the average heart rate during exercising is very well defined.

The data show that the expressed maximum heart rate values are not related to the work load. Despite the differences among individual values of maximum heart-beat rate for males and females, the average heartbeat rate is fairly equal. Men had on average 119 heartbeats per minute (118.8 ± 18.9), while women had 121 heartbeats per minute (120.9 ± 15.2). Generally looking, the average heart rate values are virtually identical. The mentioned values are represented via diagrams (diagram 1 and diagram 2).

Diagram 1. The average heartbeat of each individual for male dancers

Grafikon 2. Prosječni broj otkucaja srca svakog pojedinca – plesačice**Diagram 2.** The average heartbeat of each individual for female dancers

Na osnovu dobijenih rezultata, može se zaključiti da većina dobijenih vrijednosti spada u područje umjerenog i srednjeg intenziteta (petostepena podjela po Karpuljku, 2003). Rezultati u grafikonima 3 i 4 pokazuju da 68,4% (65 ispitanika) vježba u rasponu 60% -80% od svog maksimalnog opterećenja, njih 15,8% od izvodi vježbe sa manje od 60% svog maksimalnog opterećenja, 13,7% vježba u rasponu između 80% -90% od maksimalnog opterećenja, a 2,1%, su u najvišoj zoni, koja predstavlja 90% -100% od maksimalnog opterećenja. Rezultati ukazuju da je ples na rekreativnom nivou dovoljno zahtjevan oblik vježbanja koji intenzivno utiče na tijelo vježbača i time pomaže u očuvanju i unapređenju pripremljenosti tijela uopšte. Štaviše, predstavlja idealno sredstvo za održavanje odgovarajuće tjelesne težine i dobar način za razvoj aerobnih sposobnosti.

On the basis of the compiled data, it can be concluded that the majority of recorded values belong to the moderate and medium intensity range (the five zone division according to Karpuljko, 2003). The results shown in diagrams 3 and 4 demonstrate that 68.4% of the participants (65 of them) exercise within the 60% - 80% range of their maximum load, 15.8% of them exercise with less than 60% of their maximum load, 13.7% exercise within the range between 80% - 90% of their maximum load, and 2.1% are in the highest zone which represents 90% - 100% percent of the maximum load. The results show that recreational dancing is a fairly demanding form of exercising which has an intense impact on the body of an exerciser, and consequently it helps body maintenance, development and fitness in general. What is more, it is an ideal instrument for the maintenance of the appropriate body weight and a good method for development of aerobic abilities.

Grafikon 3. Broj vježbača po trenažnim zonama (muški, ženski, svi ispitanici)

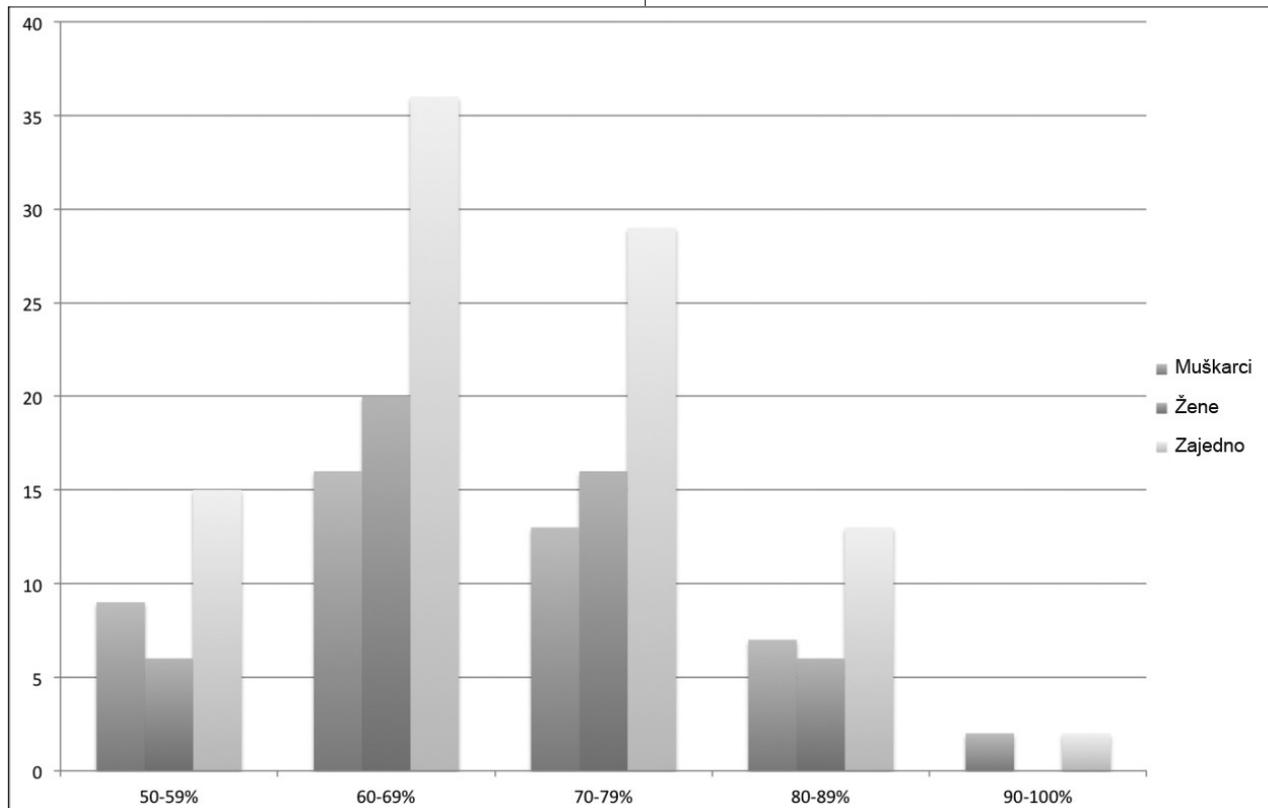


Diagram 3. Distribution of exercisers among the training zones (male, female, entire sample)

Grafikon 4. Najveći nivo opterećenja vježbanja u procentima za ukupan uzorak ispitanika

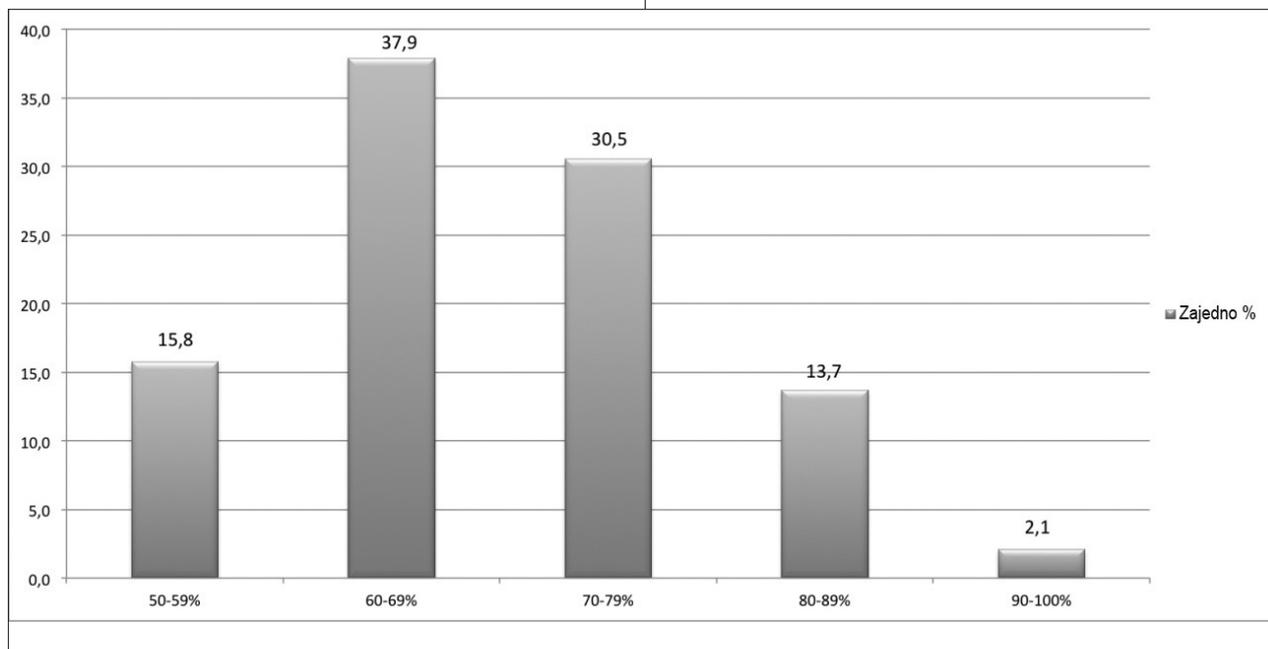


Diagram 4. The highest level of exercising load expressed in percentages for the entire sample of participants

Kada je u pitanju potrošnja energije za vrijeme rekreativnog bavljenja plesom, razlike između apsolutnih vrijednosti su znatno izraženije nego kod prosječnog broja otkucaja srca. Žene su za sat vremena plesanja u prosjeku potrošile 579 kcal ± 166 kcal (grafikon 6), dok su muškarci u istom razdoblju potrošili 769 kcal ± 296 kcal

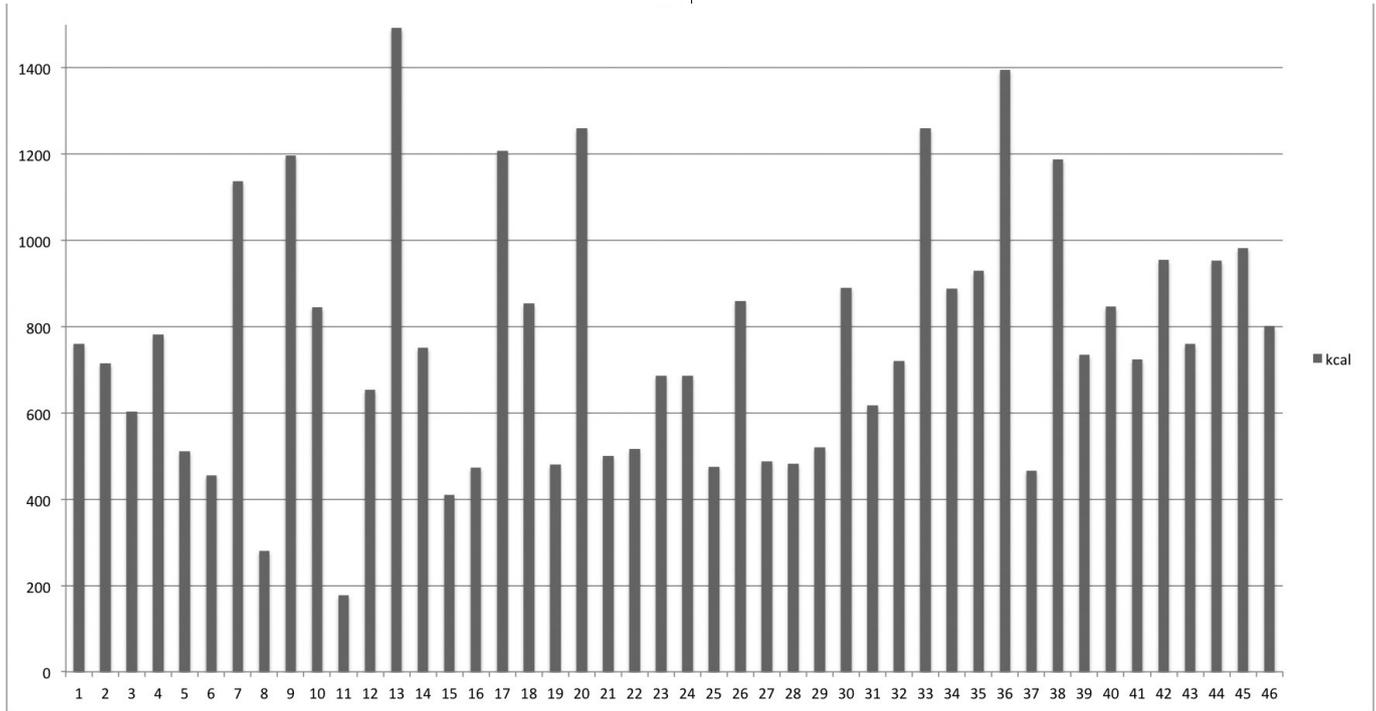
When it comes to the energy expenditure during the time of recreational dance engagement, the differences between absolute values are considerably more pronounced than with the average heartbeat. Women spent 579 kcal ± 166 kcal on average (diagram 6) in one hour of dancing, during which time men spent 769 kcal ± 296

(grafikon 5), što je 33% više nego kod ženskih ispitanika.

kcal (diagram 5), which is 33% more than women.

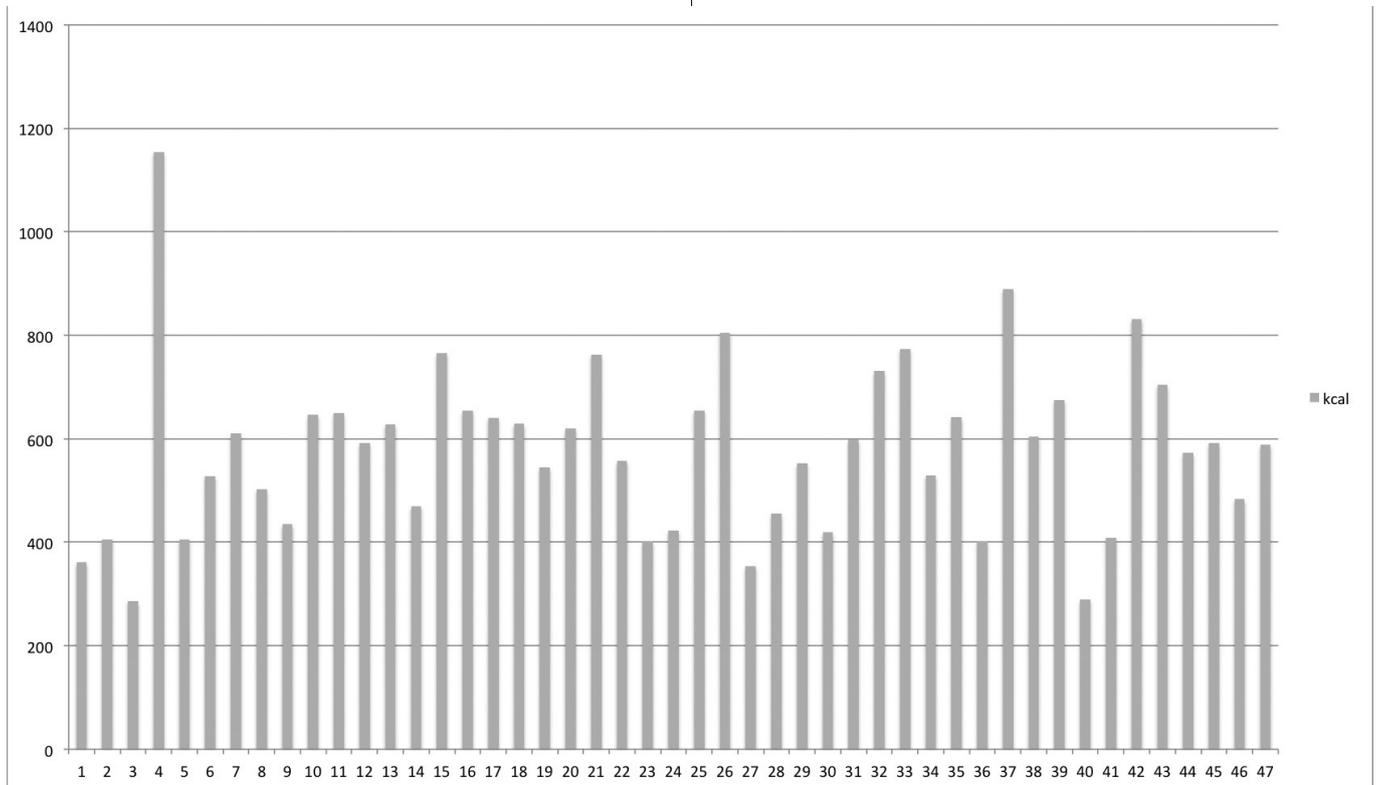
Grafikon 5. Potrošnja energije u kcal za muškarce (jedna trenažna jedinica)

Diagram 5. The energy expenditure in kcal for men (one training unit)



Grafikon 6. Potrošnja energije u kcal za žene (jedna trenažna jedinica)

Diagram 6. The energy expenditure in kcal for women (one training unit)



Zanimalo nas je jesu li te razlike, koje su bile očigledne u apsolutnim iznosima intenziteta opterećenja i potrošnji energije i statistički značajne? Rezultati prikazani u Tabeli 1 pokazuju da, u intenzitetu opterećenju između plesača i plesačica nema statistički značajnih razlika, dok je kod potrošnje energije vidljiva statistički značajna razlika.

Tabela 1. Rezultati jednosmjerne analize varijanse- ANOVA

| | Muški / Men (N=46) | | Ženski / Women (N=47) | | F | p(F) |
|---|---|--|---|--|--------|-------|
| | Aritmetička sredina / / Arithmetic mean | Standardno odstupanje / / Standard deviation | Aritmetička sredina / / Arithmetic mean | Standardno odstupanje / / Standard deviation | | |
| srčani otkucaj (udarci/min) / / Heartbeat (beat/min) | 118,81 | 18,58 | 120,90 | 15,20 | 0,359 | ,554 |
| potrošnja energije (Kcal) / / Energy expenditure (Kcal) | 769,13 | 296,48 | 579,36 | 166,43 | 14,568 | ,000* |

(Legenda: F= odnos, p(F)= nivo statističke značajnosti F odnosa, *= statistički značajna razlika na nivou 5% greške)

Kada je u pitanju potrošnja energije, mora se imati na umu da na istu utiče više faktora: sastav, pol i starost (predstavljaju bazalni metabolizam), te prehrambeni faktor i tjelesna aktivnost. Potrošnja energije za bazalni metabolizam je poprilično konstantna. Bazalni metabolizam predstavlja 60-75% svih potrebnih kalorija u jednom danu (Mayo Clinic, 2011).

Istraživanje mjernim sistemom Polar Team 2 je bilo prvo u oblasti rekreativnog plesa u Sloveniji. Dobijeni podaci pokazali su da je rekreativni ples sa stanovišta opterećenja i potrošnje energije znatno složenije područje, nego što to izgleda na prvi pogled. Razlog za to može se pripisati složenoj strukturi kretanja u plesu i različitost plesnih stilova i plesnih koreografija, jer svaki ples na svoj način traži drugačiji intenzitet pojedinca u plesu.

Do danas nije bilo puno istraživanja za mjerenje opterećenja i potrošnje energije kod plesača. Univerzitet u Wisconsinu, u slučaju istraživanja rekreativnog plesa zumba je ustanovio da se vježbanjem postiže prosječno 154 otkucaja u minuti, što je činilo 79% od maksimalnog broja otkucaja srca. Mjerenja u ovom istraživanju su pokazala da je kod rekreativnih plesača prosječna vrijednost otkucaja srca u značajnoj mjeri manja (120 otkucaja u minuti), što je razumljivo, s obzirom na različitost ove dvije plesne aktivnosti.

Veća odstupanja su prikazana i u potrošnji energije. Istraživanje na Univerzitetu u Wisconsinu govori o prosječnoj potrošnji 570 kcal, iz Adelphi Sveučilišta

We were interested whether those differences, which were apparent in the absolute values of load intensity and energy expenditure, were statistically significant. The results shown in Table 1 demonstrate that the intensity of load between female and male dancers is not statistically significant, while there is a statistically significant difference when it comes to the energy expenditure.

Table 1. Results of one way analysis of variance- ANOVA

| | Muški / Men (N=46) | | Ženski / Women (N=47) | | F | p(F) |
|---|---|--|---|--|--------|-------|
| | Aritmetička sredina / / Arithmetic mean | Standardno odstupanje / / Standard deviation | Aritmetička sredina / / Arithmetic mean | Standardno odstupanje / / Standard deviation | | |
| srčani otkucaj (udarci/min) / / Heartbeat (beat/min) | 118,81 | 18,58 | 120,90 | 15,20 | 0,359 | ,554 |
| potrošnja energije (Kcal) / / Energy expenditure (Kcal) | 769,13 | 296,48 | 579,36 | 166,43 | 14,568 | ,000* |

(Legend: F= relationship, p(F)= level of statistical significance of F relationship, *= statistically significant difference at the level of 5% error)

As for the energy expenditure, one has to have in mind that it is influenced by several factors: composition, sex and age (these represent the basal metabolism), the nutritional factor and body activity. The energy expenditure is fairly constant for the basal metabolism. The basal metabolism accounts for about 60 – 75% of all the necessary calories in one day (Mayo Clinic, 2011).

The research that utilized the Polar Team 2 system was the first such in the area of recreational dance in Slovenia. The compiled data showed that there is more complexity in recreational dance than meets the eye when one is observing the physical load and energy expenditure in it. This might be due to the complex movement structure in dancing and different dance styles and choreographies, because each dance requires different intensity from an individual.

So far, there has not been much research dealing with measuring of dancers' physical load and energy expenditure. In a research of recreational Zumba dance from the University of Wisconsin, it has been established that exercising brings the heart rate to 154 heartbeats per minute, which was 79% of the maximum heartbeat. In this research, measurements have shown that recreational dancers have a notably lower average heartbeat value (120 heartbeats per minute), which is understandable considering the difference between these two dancing activities.

Larger discrepancies have been noticed also when it comes to the energy expenditure. The research from the University of Wisconsin marked that the average expendi-

396-444 kcal, a ispitanici u ovom istraživanju 783 kcal, sve za sat vremena treninga. Takve razlike dijelom se mogu objasniti time što se radi o različitim vrstama plesa odnosno rekreativnog plesa, koji se ne izvode u istom tempu (intenzitetu) i varijacijama u plesnim koreografijama, ali i razlikama u starosti ispitanika. Osim toga, i sam intenzitet u velikoj mjeri ovisi o učitelju plesa - koliko je on u stanju motivirati vježbače.

U istraživanju potrošnje energija plesača društvenih plesova u okviru istraživanja na Mayo Clinici, dobijeni su podaci da je potrošnja 400-800 kcal za sat vremena vježbanja, ovisno uglavnom o stilu plesa koji se obavlja. Rezultati u ovom istraživanju su pokazali da su plesači prosječno potrošili 769 kcal / sat, plesačice 579 kcal / sat, odnosno za cjelokupan uzorak ispitanika prosječno 674 kcal / sat, što se slaže sa rezultatima iz klinike Mayo.

Do različitih rezultata je došao Vaszily (2005). Naime, on je ustanovio da je prosječna potrošnja energije u 265 kcal / sat, što je znatno manje od gore navedenih istraživanja. S obzirom na činjenicu da nije bilo moguće dobiti dovoljno precizne informacije o izvršenom mjerenju, razlike se mogu se tumačiti na više načina. Ispitanici u ovom istraživanju su aktivno plesali tokom cijelog sata, što i nije uvijek praksa u rekreativnim društvenim plesovima. Sam proces učenja u rekreativnim plesovima prati često mirovanje. Takođe, ovi rezultati se odnose na jednu starosnu grupu i trebalo bi isto istraživanje ponoviti sa drugim uzrastom.

ZAKLJUČAK

Istraživanje je sprovedeno sa ciljem bio da se utvrdi postojanje statistički značajne razlike u intenzitetu trenažnog opterećenja i potrošnji energije kod plesača i plesačica rekreativnog plesa. Univarijatnom analizom varijanse (ANOVA) utvrđeno je da razlike u intenzitetu opterećenja plesača i plesačica rekreativaca nisu statistički značajne, dok je kod potrošnje energije utvrđena statistička značajnost na nivou $p = .00$. Na osnovu dobijenih rezultata može se zaključiti da je rekreativni ples sa stanovišta intenziteta opterećenja i potrošnje energije znatno složenije područje, nego što to izgleda na prvi pogled. Takođe, dobijeni rezultati se podudaraju sa nekim rezultatima dosadašnjih istraživanja, ali i daju veliki značaj primjeni Polar Team 2 sistema kao mjernog uređaja, koji se pokazao kao precizan, pouzdan i jednostavan za upotrebu. Ovo istraživanje dalo je veliku količinu podataka i na osnovu dobijenih rezultata omogućena je objektivna komparacija s raznim drugim oblicima sportske rekreacije u Sloveniji i šire, te na taj način je stvorena pretpo-

ture was 570 kcal, while in a research from Adelphi University it was 396 – 444 kcal, and the participants of this research spent 783 kcal during one hour of training. These differences can be partly explained by the fact that those are different types of dance, i.e. recreational dance, which are not performed in the same rhythm and with the same variations, and also by the differences in age of the participants. In addition, the intensity itself greatly depends on a dance coach – to what extent he/she is able to motivate dancers.

In a research performed at Mayo Clinic about dancers' energy expenditure in social dances, the obtained data showed the expenditure of 400-800 kcal per one hour of exercising, depending on the style of dancing in question. The results in this research showed that the male dancers spent 769 kcal/hour on average, while the female dancers spent 579 kcal/hour, with the total for the entire sample of participants being 674 kcal/hour, which is in agreement with the Mayo Clinic results.

Vaszily (2005) got different results. Namely, he found that the average energy expenditure was 265 kcal/hour, which is significantly less than what the previously mentioned pieces of research got. Considering the fact that there was no possibility of getting the sufficiently accurate information about the advancement of measurement, the differences can be interpreted in several ways. The participants in this research danced actively during the whole hour, which is not always common in recreational social dances. The process of learning in recreational dances involves frequent resting periods. Additionally, these results apply to one age group and the same research should be repeated with another age group.

CONCLUSION

the research has been carried out with the aim of determining the existence of statistically significant difference in the intensity of training load and the energy expenditure with female and male dancers of recreational dance. The univariate analysis of variance (ANOVA) showed that the differences between male and female dancers in the intensity of the physical load are not statistically significant, while in regards to the energy expenditure there was a statistically significant difference at the level of $p = .00$. Based on the results, it can be concluded that recreational dance is much more complex than meets the eye when one is observing the physical load and energy expenditure in it. Furthermore, the results correlate with some of the results of the previous research, and also give a great importance to the application of the Polar Team2 system as a measuring device which proved to be

stavka za daljnja istraživanja. Dobijeni rezultati mogu se koristiti u programiranju treninga rekreativnog plesa.

precise, reliable and easy to use. This research produced a large amount of data and the obtained results enabled an objective comparison with other forms of sports recreation in Slovenia and in a wider region, thus creating a platform for further research. The compiled data may be used in programming of the recreational dance training.

Izjava autora

Autori pridonijeli jednako.

Authorship statement

The authors have contributed equally.

Konflikt interesa

Mi izjavljujemo da nemamo konflikt interesa.

Financial disclosure

We declare that we have no conflicts of interest.

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KORISNIČKA PERCEPCIJA SISTEMA SPORTSKIH USLUGA KARATE KLUBA

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Apstrakt: Karate klub kao sportska organizacija konstitutivno je definisana kao specifičan organizacioni sistem koji ima svoju odgovarajuću strukturu, koja se, u prvom redu, odnosi na fizičke elemente i informacione veze. U praksi strukturu većine karate klubova uglavnom karakteriše postojanje dva segmenta - organizacioni blokovi i operativne aktivnosti. Operativne aktivnosti su najodgovornije za realizaciju postavljenih ciljeva, jer se kroz njih vrši protok ljudi - korisnika usluga i ljudskih resursa organizacije. S obzirom da danas karate klubovi u najvećem broju egzistiraju kao udruženja (neprofitne organizacije), na njih se sasvim aplikativno odnosi teorijsko stanovište da uspeh neprofitnih organizacija upravo zavisi od činjenice koliko efektivno i efikasno zadovoljavaju potrebe svojih korisnika. Odnosno, u kojoj meri raspoložu organizacionim kapacitetima koji su u stanju da „sportskom tržištu“ isporuču efektivnu uslugu.

Takođe, kompleksnost ciljeva karate kluba kao neprofitne sportske organizacije imanentna je i složenom individualnom doživljaju konzumenta usluge u celini, čime se profiliše pažnja davaoca usluge ka zadovoljstvu korisnika. Stoga je pitanje adekvatne percepcije relacije „kvalitetna usluga – zadovoljstvo korisnika“ veoma kompleksno, suptilno i delikatno, te često zavisi prevashodno od različitih pogleda korisnika i njihovog shvatanja (poimanja) kvaliteta. Ovo se, svakako, mora uzeti u obzir prilikom različitih aktivnosti evaluacije od strane menadžmenta sportske organizacije.

Empirijsko istraživanje koje je realizovano na uzorku od 215 ispitanika korisnika usluga karate kluba „Yu Karate Do“ iz Novog Sada imala je za cilj uveriti u poželjnost jedinih činilaca kojima se može vršiti valorizacija rada i kvaliteta usluga koje pruža klub, na osnovu percepcije i zadovoljstva neposrednih korisnika. Dobijeni rezultati su pokazali da korisnici usluga predstavljaju značajnu odrednicu valorizacije njegovog rada, s obzirom da kroz svoje stavove i mišljenja iskazuju vrlo precizne i eksplicitne odrednice o pojedinim činiocima sistema usluga i rada kluba.

Ključne reči: sportske usluge, korisnici, karate klub.

USERS' PERCEPTION OF A SPORTS SERVICE SYSTEM IN A KARATE CLUB

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Abstract: A karate club as a sports organization is constitutively defined as a specific organizational system which has its appropriate structure that primarily relates to physical elements and informational communication. In practice, the structure of most karate clubs is mainly characterized by the existence of two segments: organizational units and operational activities. Operational activities are the most responsible for realization of goals, because through them there is a flow of people such as service users and human resources of an organization. Considering that nowadays karate clubs mostly exist as associations (non-profit organizations), a theoretical assumption that the success of non-profit organizations depends on the effective and efficacious meeting of their users' needs definitely applies to them, namely, it depends on their organizational capacity to deliver an effective service to the "sports market". Furthermore, the complexity of a karate club's goals as a non-profit sports organization is also bound by the complex individual experience of consumers in general, which directs attention of the service providers toward satisfaction of their users. Therefore, the question of adequate perception of the relation between "quality service" and "satisfaction of users" is very complex, subtle, and delicate, and it often primarily depends on different views of users and their understanding (notions) of what quality is. This, surely, has to be taken into consideration during different evaluative activities performed by the management of a sports organization. The goal of the empirical research realized on a sample of 215 participants, the service users of "Yu Karate Do" club from Novi Sad, was to determine specific factors which can be used for evaluation of work and service quality provided by a club based on the perception and satisfaction of its immediate users. The results showed that the users represent a significant determinant in evaluation of the club's work, considering that through their attitudes and opinions they express very precise and explicit determinants about certain factors in the service system and the work of the club.

Key words: sports services, users, karate club.

Uvod

Kada se razmatraju pitanja različitog konteksta pružanja usluga u savremenom životnom i radnom okruženju, neophodno je poći od konstatacije da su usluge (u najširem kontekstualnom obuhvatu) rezultat umnih i/ili fizičkih (društveno-korisnih) delatnosti koje suštinski nisu proizvodnog karaktera. Posmatrane na ovaj način usluge se javljaju i u sportskoj delatnosti, kao karakterističnoj društvenoj sferi vanprivrednog karaktera.

U najširem smislu može se reći da usluge predstavljaju dela, procese i performanse (Vargo & Morgan, 2005). Usluga uključuje sve ekonomske aktivnosti čiji je rezultat neopipljiva forma (gledano u celini), koja se uglavnom troši na mestu gde se i proizvodi, te pruža korist za osobu koja tu uslugu koristi (kupuje). Jedna od najprisutnijih definicija u savremenoj literaturi kaže da je *usluga svaka aktivnost ili korist koju jedna strana nudi drugoj i koja je suštinski neopipljiva i ne rezultira u vlasništvu nad bilo čim*. Njena proizvodnja može, ali ne mora biti povezana sa fizički opipljivim dobrom (Vargo & Morgan, 2005; prema: Popović, 2012, str. 17).

Za kreiranje i distribuciju usluga neophodno je imati u vidu i pojam uslužnog ambijenta, koji obuhvata različite elemente fizičkog okruženja i atmosferu u kojoj se usluga obavlja. Njime se znatno utiče na sam proces pružanja usluge, kao i na percepciju potrošača (korisnika/konzumenta) (Gronroos, 2002).

Sport kao i svaka javna delatnost treba da čoveku pruži određenu uslugu. Sportske usluge treba da budu dostupne najširim slojevima društva jer zadovoljavaju različite potrebe i imaju različito dejstvo na potencijalne korisnike (Popmihajlov-Zeremski, 2010, str. 10). Za sportsku uslugu se može reći da predstavlja određeno delovanje, aktivnost ili akciju u kojoj davalac usluge (s jedne strane) usmerava svoju ponudu korisniku usluge (s druge strane), u vidu telesnih vežbi, sportske obuke, aktivnog odmora, zabave, ili pak, psihofizičkih zadovoljstava (Nešić, 2008). Sportska usluga se može pojaviti u samostalnom obliku, kao čista sportska usluga (aerobik, sportska masaža, sportska obuka i sl.), ili u kombinaciji sa drugim sportskim proizvodima (npr. korišćenje sprava i rekvizita u sportskim centrima i/ili klubovima sa uslugama stručnog lica koje vodi vežbovni proces, i sl.). Da bi objekti razmene bili i proizvod, moraju da ispunjavaju neke od uslova i to: da usluga bude takva *da zadovoljava potrebe; da ima upotrebnu vrednost*, odnosno da nekome koristi i da je neko treba, te *da ima prometnu vrednost* (Nešić & Popmihajlov-Zeremski, 2011).

Danas se u svetu menadžmentskog upravljanja organizacijama neprofitnog sektora, a posebno u svetlu

INTRODUCTION

When we consider matters of different contexts where services can be provided in modern life and work environment, it is necessary to start with the assertion that services (in their broadest contextual scope) are a result of mental and/or physical (socially useful) activities which are not essentially characterized by production. Observed in this way, services occur both in the sports industry as well as in a peculiar non-economic social sphere.

In the broadest sense, it can be said that services are actions, processes, and performances (Vargo & Morgan, 2005). A service includes all economic activities which result in intangible commodity (generally looking), which is mainly spent at the place where it is produced, and provides benefits for a person who uses (purchases) the service. One of the most common definitions in the contemporary literature says that a *service is any activity or benefit that one party offers to another which is essentially intangible and does not result in the ownership of anything*. Its production may or may not be affiliated with physically tangible goods (Vargo & Morgan, 2005; according to: Popović, 2012, p. 17).

For creation and distribution of services it is necessary to have in mind the concept of the service environment that includes various elements of the physical environment and atmosphere in which the service is performed. It has a significant impact on the process of providing services, as well as on the perception of consumers (users) (Gronroos, 2002).

Sport as any public activity should offer a person a particular service. Sports services should be available to the widest ranges of society because they satisfy different needs and have different effects on potential users (Popmihajlov-Zeremski, 2010, p. 10). It can be said that a sports service represents a specific work, activity or action in which the service provider (on one side) directs its service toward the client (on the other side), in the form of physical exercises, sports training, active holidays, recreation, or psychophysical pleasures (Nešić, 2008). A sports service can occur in an independent form, as a pure sports service (aerobics, sports massage, sports training, etc.), or in combination with other sports products (e.g. the use of gear and equipment in sports centers and/or clubs with an assistance of a professional responsible for conducting the training process, etc.). In order for the exchange objects to be products, they must fulfill some of the conditions, namely: that a service is such as *to meet the needs; that it has a practical value*, i.e. that it is useful for someone and that someone needs it, and that *it has an exchange value* (Nešić & Popmihajlov-Zeremski, 2011).

There is a prevalent viewpoint in today's world of management of non-profit organizations, especially hav-

marketinškog pristupa upravljanja promenama, jasno pozicioniralo stanovište da uspeh neprofitnih organizacija upravo zavisi od činjenice koliko efektivno i efikasno zadovoljavaju potrebe svojih korisnika (Kaplan, 2001). Kako su karate klubovi kao sportske organizacije u većini slučajeva organizaciono neprofitno orijentisani može se govoriti o veoma značajnoj aplikativnosti prethodne konstatacije, posebno u svetlu odgovora na pitanje - koliko su odgovorne, pre svega, prema svojim klijentima (korisnicima usluga), ali i prema donatorima, javnim izvorima finansiranja, itd. Odnosno, u kojoj meri raspolažu organizacionim kapacitetima koji su u stanju da „sportskom tržištu“ isporuče efektivnu uslugu (Dačić, 2014).

Takođe se u ovom kontekstu mora imati u vidu i to da je kompleksnost ciljeva neprofitnih organizacija (pa tako i karate klubova) imanentna složenom individualnom doživljaju konzumenta usluge u celini (pa tako i njenog kvaliteta), profilišući pažnju davaoca usluge ka zadovoljstvu korisnika. Pored objektivnog doživljaja usluge (i njenog kvaliteta) postoji i subjektivni faktor koji veoma zavisi od ličnih karakteristika, uverenja i očekivanja, individualnih obrazaca usvojenih sistema vrednosti, navika, stremljenja i želja, itd. (prema: Evans & Lindsey, 2010). Stoga je pitanje adekvatne percepcije relacije „kvalitetna usluga – zadovoljstvo korisnika“ veoma kompleksno, suptilno i delikatno, te često zavisi prevashodno od različitih pogleda korisnika i njihovog shvatanja (poimanja) kvaliteta (Dačić, 2014, str. 33). Ovo se, svakako, mora uzeti u obzir prilikom različitih aktivnosti evaluacije od strane menadžmenta karate kluba.

METOD

U okviru šire istraživačke studije (Dačić, 2014), a vezano za aspekt ovog rada, primenom Servej metoda bila je obuhvaćena i identifikacija individualne percepcije zadovoljstva korisnika pojedinim elementima iz sistema sportskih usluga karate kluba.

Uzorak ispitanika sačinjavalo je 215 korisnika sportskih usluga karate kluba “Yu Karate Do” iz Novog Sada. Utvrđivanje percepcije resursnih elemenata iz sistema sportskih usluga ovog kluba, kroz identifikaciju zadovoljstva njegovih nesporednih korisnika, izvršeno je putem dva indikatora (anketnih pitanja): 1) čime su korisnici usluga kluba *najzadovoljniji*, i 2) čime korisnici usluga kluba *nisu zadovoljni*.

Podaci prikupljeni u empirijskom delu istraživanja sređeni su i uneti u bazu koja je formirana u aplikativnom statističkom programu SPSS, a zatim su podvrgnuti odgovarajućim statističkim procedurama.

ing in mind a marketing approach to change management, that the success of non-profit organizations depends on the fact how effectively and efficiently they meet the needs of their customers (Kaplan, 2001). Since karate clubs as sports organizations in most cases function as non-profit organizations, this indicates very significant applicability of the previous observations, particularly, in regards to the question - how accountable are they, primarily to their clients (service users), but also to donors, public sources of funding, etc. That is, what is the extent of their organizational capacities to deliver an effective service to “sports market” (Dačić, 2014).

Furthermore, in this context one has to have in mind that the complexity of goals of non-profit organizations (and thus karate clubs) is also bound by a complex individual experience of consumers of a service in general (thus its quality), which directs the attention of service providers toward satisfaction of their users. In addition to the objective experience of a service (and its quality), there is a subjective factor that is highly dependent on personal characteristics, beliefs and expectations, individual patterns, adopted value systems, habits, aspirations and desires, etc. (According to: Evans & Lindsey, 2010). Therefore, the issue of adequate perception of the relation between “quality service” and “customer satisfaction” is very complex, subtle and delicate and often primarily depends on users’ different views and their understanding (notions) of what quality is (Dačić, 2014, p. 33). This, surely, has to be taken into account during different evaluative activities performed by the management of a karate club.

METHOD

As a part of a wider research study (Dačić, 2014), and related to an aspect of this work, identification of individual perceptions of customer satisfaction with individual elements of the sports service system of a karate club was performed via the survey method.

The sample consisted of 215 users of sports services of a karate club “Yu Karate-Do” from Novi Sad. Determining perceptions of resource elements from the sports service system of this club, through identifying the satisfaction of its direct users was carried out via two indicators (survey questions): 1) what makes the customers of the club *most satisfied*, and 2) what makes the customers of the club *dissatisfied*.

Data collected in the empirical part of the research have been arranged and inserted into the database which was formed in the applicative statistical program SPSS, and then the data were subjected to appropriate statistical procedures.

REZULTATI I DISKUSIJA

Socijalni stavovi kao motivaciona podloga čovekovog angažovanja u određenoj oblasti značajni su za utvrđivanje pojedinih karaktera same aktivnosti, posebno u pravcu vođenja računa o, npr: njegovim doživljajima u oceni i shvatanju određene situacije, emocijama kojima reaguje na spoljašnje i unutrašnje faktore aktivnosti, akcijama kojima menja situacije, itd. Posebno je ovo značajno u procesima koji dominiraju u sportskoj delatnosti, a time i u karate sportu. To znači da stav pojedinca, kao stečena dispozicija, poseduje snagu spremnosti da se na određeni način opaža, misli, emocionalno reaguje i deluje.

Uvažavajući ovakve teorijske odrednice deo rezultata istraživanja identifikovan je kroz opšte stavove ispitanika prema karateu. Skalarnе vrednosti odgovora ispitanika, koje su i u ovom istraživanju detektovane pomoću skale opšteg stava prema karateu (sa 15 ajtema) u celini ukazuju na egzistenciju visoko pozitivnog opšteg stava prema karate sportu ($S_v=4,16$), što potvrđuje do sada identifikovano stanovište i iz ranijih sličnih istraživanja (Nešić, 2005) da u sportskom okruženju kod nas egzistira opšte mišljenje o pozitivnim (društvenim) vrednostima karatea kao sporta. Ovako formiran stav o opštim aspektima karate sporta kao društvene kategorije, predstavlja veoma dobru motivacionu podlogu za uključivanje pojedinaca u aktivnosti karate klubova, odnosno korišćenja sportskih usluga određenih karate organizacija kao mesta neposredne realizacije (prvenstveno) trenažnog karate procesa (Dačić, 2014). Generalno pozitivan stav neposrednih učesnika u aktivnostima karate sporta prema ovoj sportskoj grani i nekim njenim aspektima je, svakako, značajna osnova i za proces kreiranja adekvatnih sportskih usluga u konkretnom organizaciono-menadžmentskom okruženju (karate klubu).

Psiho-socijalna teorija do sada je pozicionirala stanovište da je težnja za zadovoljstvom jedan od osnovnih pokretača čoveka na akciju. Sa ovog aspekta možemo i posmatrati zadovoljstvo kao deo personalnih dispozicija čoveka koji su u sadejstvu sa njegovim stavovima i motivima (Dunđerović, 2004). Zadovoljstvo, u suštini, predstavlja relativnu kategoriju individualnih pogleda na stvarnost koja se može razlikovati u zavisnosti od sposobnosti, znanja, ambicija, očekivanja, percepcija, životnih stremljenja pojedinca, itd. (Đurić, 2007).

U ovakvom kontekstu posmatranja pojma izvršena je identifikacija i analizira konteksta - u kojoj su meri i čime ispitanici zadovoljni, odnosno nezadovoljni, kada je reč o sistemu sportskih usluga u karate klubu „Yu Karate Do“ čiji su oni korisnici. Za potrebe istraživanja u an-

RESULTS AND DISCUSSION

Social attitudes as the motivational background of a person's engagement in a certain field are important for determination of specific characteristics of the activity itself, especially in regards to for example: his/her experiences in evaluation and understanding of a certain situation, the manner in which he/she emotionally reacts to outer and inner factors of an activity, actions which he/she undertakes to change situations etc. This is especially significant in the processes that dominate sport and hence karate sport. This means that the attitude of an individual, as an acquired disposition, has the potential to be noticed, thought, and emotionally reacted and acted out in a certain way.

Taking into account these theoretical determinants, a part of the research results has been identified through the general attitudes toward karate. Scale values of the responses as a whole that are based on formed attitude about general aspects indicate the existence of a highly positive general attitude towards the karate sport (4.16), which is also confirmed by thus far identified standpoint from previous similar studies (Nešić, 2005) that there is a generally positive opinion in our country's sports environment about the (social) values of karate as a sport. Thus formed attitude about general aspects of this sport as a social category is a very good motivational basis for the inclusion of individuals in the activities of karate clubs, that is, in the use of sports services of certain karate organizations as places of immediate implementation of (primarily) karate training process (Dačić, 2014). A generally positive attitude of direct participants in karate activities toward this sports branch and some of its aspects is certainly a significant foundation for the process of creating adequate sports services in the specific organizational and managerial environment (in a karate club).

The psychosocial theory has thus far accepted the view that the pursuit of pleasure is one of the main drives of human action. In this aspect we can also observe satisfaction as a part of one's personal dispositions that acts in unison with a person's views and motives (Dunđerović, 2004). Satisfaction, in essence, represents a relative category of individual outlook on life which can vary depending on one's ability, knowledge, ambitions, expectations, perceptions, life aspirations of an individual, etc. (Đurić, 2007).

An analysis and identification of the context have been carried out in the mentioned observational framework of a notion - to what extent are participants satisfied, that is, what makes them satisfied or dissatisfied when it comes to the service system in the karate club "Yu Karate Do" whose services they have been using. For the purposes of the research, two questions (of the

ketnom upitniku su kreirana dva pitanja (otvorenog tipa) na koja su ispitanici odgovarali slobodnim upisivanjem odrednica: (1) šta im se najviše *dopada* u klubu i (2) šta im se *ne dopada* u klubu. Odgovori su upisivani na način hijerarhijskog rangiranja po tri najkarakterističnije pojave (najdominantniji stepen (ne)zadovoljstva) u svakom ajtemu.

Uvidom u distribucije odgovora ispitanika može se uočiti hijerarhijsko rangiranje pojedinih činilaca iz sistema usluga kluba koje korisnici percipiraju u pozitivnom kontekstu (Tabela 1). Analizom njihovog sadržaja izdiferenciralo se po devet karakterističnih elemenata usluge na koje njihovi „konzumenti” obraćaju najveću pažnju. Tako se u pogledu zadovoljstva (stvari koje im se u klubu najviše dopadaju) na prva tri mesta izdvajaju: *treneri*, *drugarska atmosfera* koja vlada u klubu i *kvalitet stručnog rada*. Potom slede: *programi vežbanja* koji se sprovode u klubu, *odnos trenera prema vežbačima* (posebno deci), *oprema i rekviziti* koji se koriste u trenažnom procesu, *organizacija kluba* u celini, *disciplina* koja vlada tokom treninga i *lokacija sale* za vežbanje; mada u manjem intenzitetu ispoljavanja (distribucija odgovora ispitanika mnogo manja u odnosu na prva tri elementa koja zajednički obuhvataju 54,4% odgovora). Dakle reč je o indikatorima koji su direktno povezani, pre svega, sa organizacijom i realizacijom trenažnog procesa.

Tabela 1. Rangiranje elemenata usluga koje se najviše dopadaju korisnicima

| Rang / Rank | Činilac usluge / Service factor | f | % | Valid % |
|----------------------------|--|------------|--------------|---------|
| 1 | Treneri / Coaches | 46 | 21,4 | 27,4 |
| 2 | Drugarska atmosfera / Friendly atmosphere | 39 | 18,1 | 23,2 |
| 3 | Stručni rad / Professional work | 32 | 14,9 | 19,0 |
| 4 | Programi / Programs | 19 | 8,8 | 11,3 |
| 5 | Odnos trenera prema vežbačima / Coach's attitude toward athletes | 16 | 7,4 | 9,5 |
| 6 | Oprema i rekviziti / Equipment and gear | 7 | 3,3 | 4,2 |
| 7 | Organizacija kluba / Club's organization | 5 | 2,3 | 3,0 |
| 8 | Disciplina / Discipline | 3 | 1,4 | 1,8 |
| 9 | Lokacija sale / Location of the gym | 1 | ,5 | ,6 |
| Svega / Total | | 168 | 78,1 | 100,0 |
| Bez odgovora / No response | | 47 | 21,9 | |
| Ukupno / Total | | 215 | 100,0 | |

Određeni stepen nezadovoljstva, odnosno eksplicitno ukazivanje na pojave koje mogu dovesti u pitanje kvalitet usluga kluba, te se moraju prihvatiti kao značajan indikator i tačka aktivnosti kojoj menadžment kluba

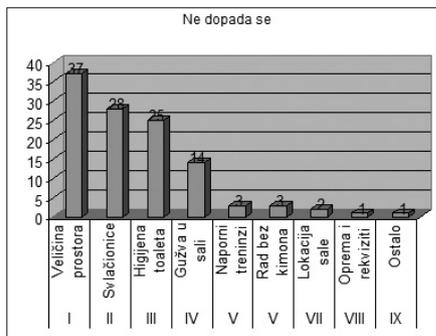
open type) were created in the survey to which respondents freely wrote their answers: 1) what do they *like* most in the club? and 2) what do they *dislike* in the club? The responses were written in a hierarchical ranking via three most characteristic phenomena (the most dominant level of (dis) satisfaction) in each item.

After examination of the participants' answer distribution, there can be noticed a hierarchical ranking of the specific factors from the club's service system that users perceive in a positive manner (Table 1). An analysis of their content differentiated nine distinguishing service elements to which its "consumers" pay the most attention. Thus, in terms of satisfaction (things that they like the most in the club) there are top three things standing out: *coaches*, *a friendly atmosphere* in the club and *the quality of professional work*. These are followed by: *the exercise programs* carried out in the club, *the coach's attitude toward athletes* (especially children), *the equipment and gear* used in the training process, *organization of the club* as a whole, *discipline* that is present during trainings and *the location of the gym*; although to a lesser intensity of manifestation (distribution of answers is much lower compared to the first three elements which comprise in total 54.4% of responses). Therefore, this relates to the indicators that are directly and chiefly associated with the organization and implementation of the training.

Table 1. Ranking of the service elements that the users like the most

A certain degree of dissatisfaction, namely, the explicit indication of the phenomena that can jeopardize the quality of service in the club, must be accepted as a significant indicator and a focal point to which the club's management

mora posvetiti mnogo veću pažnju, iskazan je dominantno kroz, takođe, devet indikatora (Slika 1). U pogledu nezadovoljstva (nedopadanja) korisnika na prva tri mesta se nalaze elementi usluga: *veličina prostora* u kome radi klub (odnosno, realizuje trenažni proces), *veličina, broj i higijena u svlačionicama i higijena u toaletima*. Ovi indikatori imaju i najveću distribuciju među odgovorima ispitanika (vidljivo kroz apsolutne frekvencije- 90 ispitanika, odnosno 41,6%). Potom slede elementi: *gužva u sali* za vežbanje u pojedinim trenažnim grupama (uglavnom kada je reč o mlađim uzrasnim kategorijama vežbača, odnosno polaznicima „karate škole“), *naporni treninzi* (najvećim delom se ovo odnosi na percepciju od strane povremenih rekreativnih vežbača), *vežbanje bez kimona* (kao najkarakterističnijeg obeležja karatea), *lokacija sale* (u ovom kontekstu se pojavljuju isključivo roditelji), *oprema i rekviziti* (u smislu njihove istrošenosti).



Slika 1. Frekvencije elemenata usluga koje se ne dopadaju korisnicima

Upoređivanjem distribucija odgovora različitih kategorija ispitanika na pitanje vezano za dopadanje, odnosno nedopadanje, a koje je povezano sa njihovom percepcijom pojedinih činilaca iz sistema sportskih usluga kluba, uočene su i statistički značajne razlike. To potvrđuju i rezultati kontingencijske analize gde se može uočiti distribucija po važnosti koje ispitanici različitog korisničkog statusa pridaju pojedinim elementima usluga. Tako, na primer, takmičari su najzadovoljniji (Tabela 2) elementima koji se odnose na *trenere* koji sa njima rade, *atmosfera* koja vlada u klubu (pre, za vreme i nakon treninga) i *kvalitet stručnog rada*; dok su najkritičniji prema *svlačioničkom prostoru* (veličini i higijeni), *veličini prostora* u kome klub realizuje svoje aktivnosti i *higijeni toaleta*. Sa druge strane, roditelji (kao karakteristični eksterni stejkholderi) su najzadovoljniji *kvalitetom stručnog rada* i *odnosom trenera prema deci*, što je uopšte povezano sa pozitivnom percepcijom trenerskog kadra u ovom klubu; dok su najkritičniji prvenstveno u odnosu na *veličinu prostora* u kojem klub radi i *higijenu toaleta* (dok ostali elementi usluge gotovo i da nisu eksplicitno navođeni) (Tabela 3).

must devote much more attention; this is also clearly expressed through the nine indicators (Figure 1). In terms of users' dissatisfaction (dislikes), the first three places belong to the service elements: *the size of the exercise room* in the club (i.e. where training takes place), the size, number and hygiene in the *locker rooms* and *hygiene in toilets*. These indicators have the largest distribution among the respondents' responses (visible in absolute frequencies from 90 users in this research, 41.6%). They are followed by these elements: *crowd in the gym* in certain training groups (mainly with regard to the younger age groups of athletes, i.e. "karate school" attendees), *strenuous training* (for the most part this applies to the perception of members who come occasionally and recreationally), *exercising without kimono* (as the most distinguishing feature of karate), *the location of the gym* (only parents appear in this context), *gear and equipment* (in terms of their wear and tear).

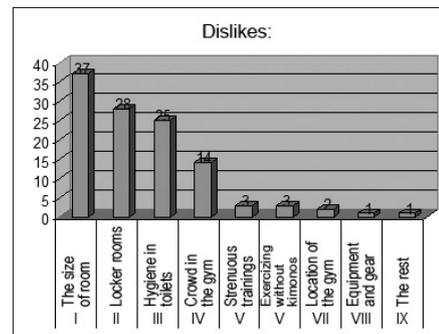


Figure 1. The frequency of service elements disliked by the users

A comparison of distributions of responses through various user categories related to the questions of liking or disliking, which are connected to their perception of certain factors from the club's sports service system, resulted in statistically significant differences. This is confirmed by the results of the contingency analysis where one can notice the distribution according to the importance that respondents of different user status attach to specific elements of service. Thus, for example, competitors are most satisfied (Table 2) with the elements that are connected to the *coaches* who work with them, *the atmosphere* in the club (before, during, and after training) and *the quality of professional work*; while they are most critical toward *locker rooms* (their size and hygiene), *the size of the exercise room* in the club and *hygiene in toilets* (while other service elements are not explicitly mentioned) (Table 3).

Tabela 2. Distribucija odgovora o elementima usluga koje se najviše dopadaju ispitanicima različitog korisničkog statusa

Table 2. Distribution of responses about the service elements which respondents of different user status like the most

| Činilac usluge / / Service element | Korisnički status / User status | | | | Σ |
|---|---------------------------------|---|--|-------------------|---------------|
| | takmičar / / competitor | red. rek. vežbač / / reg. rec. athlete | pov. rek. korisnik / / occ. rec. user | roditelj / parent | |
| Stručni rad / / Professional work | 9 5,4% | 5 3,0% | 5 3,0% | 13 7,7% | 32 19,0% |
| Programi / / Programs | 6 3,6% | 9 5,4% | 2 1,2% | 2 1,2% | 19 11,3% |
| Treneri / / Coaches | 21 12,5% | 14 8,3% | 1 ,6% | 10 6,0% | 46 27,4% |
| Oprema i rekviziti / / Equipment and gear | 1 ,6% | 2 1,2% | 2 1,2% | 2 1,2% | 7 4,2% |
| Odnos trenera prema vežbačima / / Coach's attitude toward athletes | 5 3,0% | 2 1,2% | 0 ,0% | 9 5,4% | 16 9,5% |
| Organizacija kluba / / Club's organization | 5 3,0% | 0 ,0% | 0 ,0% | 0 ,0% | 5 3,0% |
| Drugarska atmosfera / / Friendly atmosphere | 10 6,0% | 13 7,7% | 3 1,8% | 13 7,7% | 39 23,2% |
| Disciplina / / Discipline | 2 1,2% | 1 ,6% | 0 ,0% | 0 ,0% | 3 1,8% |
| Lokacija sale / / Location of the gym | 1 ,6% | 0 ,0% | 0 ,0% | 0 ,0% | 1 ,6% |
| Σ | 60 35,7% | 46 27,4% | 13 7,7% | 49 29,2% | 168 100,0% |

$X^2=44,130$

Sig = ,007

$X^2=44,130$

Sig = .007

Tabela 3. Distribucija odgovora o elementima usluga koje se najviše ne dopadaju ispitanicima različitog korisničkog statusa

Table 3. Distribution of responses about the service elements which respondents of different user status dislike the most.

| Činilac usluge / / Service element | Korisnički status / User status | | | | Σ |
|--|---------------------------------|---|--|-------------------|---------------|
| | takmičar / / competitor | red. rek. vežbač / / reg. rec. athlete | pov. rek. korisnik / / occ. rec. user | roditelj / parent | |
| Svlačionice / / Locker rooms | 18 15,8% | 10 8,8% | 0 ,0% | 0 ,0% | 28 24,6% |
| Veličina prostora / / Size of room | 9 7,9% | 7 6,1% | 5 4,4% | 16 14,0% | 37 32,5% |
| Higijena toaleta / / Hygiene in toilets | 8 7,0% | 7 6,1% | 4 3,5% | 6 5,3% | 25 21,9% |
| Gužva u sali / / Crowd in the gym | 5 4,4% | 2 1,8% | 4 3,5% | 3 2,6% | 14 12,3% |
| Oprema i rekviziti / / Equipment and gear | 1 ,9% | 0 ,0% | 0 ,0% | 0 ,0% | 1 ,9% |
| Naporni treninzi / / Strenuous trainings | 0 ,0% | 3 2,6% | 0 ,0% | 0 ,0% | 3 2,6% |
| Rad bez kimona / / Exercising without kimonos | 1 ,9% | 0 ,0% | 0 ,0% | 2 1,8% | 3 2,6% |
| Lokacija sale / / Location of the gym | 0 ,0% | 0 ,0% | 0 ,0% | 2 1,8% | 2 1,8% |
| | 1 ,9% | 0 ,0% | 0 ,0% | 0 ,0% | 1 ,9% |
| Σ | 43 37,7% | 29 25,4% | 13 11,4% | 29 25,4% | 114 100,0% |

$X^2=57,997$

Sig = ,000

$X^2=57,997$

Sig = .000

U svetlu ovakvih rezultata istraživanja može se konstatovati da se i ovom prilikom potvrdilo poznato teorijsko stanovište da različite potrebe ljudi u domenu fizičkog vežbanja, odnosno sportskog angažovanja, u prvi plan postavljaju i pitanje mogućnosti egzistencije i realizacije njihovog sadržaja. U ovom slučaju kroz određivanje prema karate sportu. Zbog toga se može govoriti o karate klubovima kao relevantnim mestima za realizaciju potreba ljudi u oblasti sporta i fizičkog vežbanja, kroz odabrani borilački sport (i/ili veštinu).

U celini gledano sportske usluge karate kluba treba da budu dostupne najširim slojevima društva, jer zadovoljavaju različite potrebe i imaju različito dejstvo na potencijalne korisnike (Nešić, 2008). Zbog toga se može smatrati da i njih treba da karakteriše odrednica – „na dohvata ruke“ svakom zainteresovanom pojedincu. Naravno da je teško izvršiti sveobuhvatnu identifikaciju i klasifikaciju svih sportskih i/ili sportsko-rekreativnih usluga koje jedan karate klub može da pruži svojim korisnicima, između ostalog i iz razloga što se iz dana u dan pojavljuju novi zahtevi korisnika, kao i novi modeli sportskih i sportsko-rekreativnih sadržaja uopšte, pa tako i u sferi borilačkih sportova (time i karatea). Međutim, dosadašnja praksa, pokazala je da se najveći broj uslužnih aktivnosti može svrstati u četiri osnovne kategorije (Nešić, 2013), što može svakako biti aplikativno i u odnosu na karate: 1) usluge u mestu stanovanja korisnika, 2) usluge van mesta stanovanja korisnika, 3) aktuelne i nove usluge, i 4) ostale (prateće) usluge vezane za karate sport.

ZAKLJUČAK

Istraživanje je pokazalo da se upravo usluge u mestu stanovanja neposrednih korisnika, sa aspekta karate kluba kao „davaoca“ usluge, moraju ozbiljnije tretirati i razvijati, naročito u pogledu odnosa menadžmenta kluba prema direktnim korisnicima koji mogu imati različite korisničke i/ili stejkholderske uloge. Odnosno, da se korisnici usluga karate kluba u mestu svoga stanovanja moraju smatrati (i prihvatati) kao aktivni i relevantni činioci njegove poslovne valorizacije.

Rezultati istraživanja u kojem su detektovani stavovi i zadovoljstvo ispitanika prema pojedinim aspektima sistema sportskih usluga karate kluba „Yu Karate Do“, a koji su u različitim ulogama i sa specifičnim razlozima bili njihovi korisnici, omogućili su identifikaciju elemenata na osnovu kojih je moguće odrediti činioce hipotetskog modela valorizacije sistema sportskih usluga koje ovaj klub pruža svojim korisnicima.

Konstrukta za modelovanje valorizacionih činilaca usluga u KK „Yu Karate Do“ obuhvaćen je identifikovani

Judging from these results, it can be concluded that the research confirmed the well-known theoretical standpoint that people's different needs in the field of physical exercise or sports activity, bring out the question of possibility of existence and implementation of their content. In this case, that goes through the commitment to sports karate. Therefore, we can talk about karate clubs as relevant places for realization of people's needs in the field of sport and physical exercise through a selected combat sport (and/or skill).

Generally, karate club's sport services should be available to the widest layers of society, as they meet different needs and have different effects on potential users (Nešić, 2008). Therefore, it is thought that they should be characterized by designation - "within reach" to each interested individual. Of course, it is difficult to make a comprehensive identification and classification of all sports and/or recreational sports services that one karate club can offer to its customers, and one reason for this is that new user requirements appear on a daily basis, as well as new models of sports and recreational sports facilities in general, which also include the sphere of combat sports (and hence karate). However, the previous practice has shown that the largest number of service activities can be classified into four basic categories (Nešić, 2013), which can certainly be also applied to karate: 1) services in the users' place of residence, 2) services outside of the users' place of residence 3) current and new services, and 4) the other (supporting) services related to karate.

CONCLUSION

From the karate club's perspective as the one offering services, the research has shown that the services in the place of residence of direct users in particular ought to be treated seriously and developed further; especially when it comes to the relation between the club's management and their immediate customers who may have different user and/or stakeholder roles. This means that the customers of a karate club in the place of their residence must be considered (and accepted) as active and relevant factors of its business evaluation.

The results of the research on certain aspects of "Yu Karate-Do" karate club's sport service system that have indicated attitudes and satisfaction of the respondents, who are club's customers in different roles and with specific reasons, have enabled identification of the elements that can be used as a basis for determination of hypothetical evaluation model factors for the sports service system that this club offers to its users.

The scheme for modeling the service evaluation

vanim istraživačkim sadržajima, među kojima se nalaze i sledeći:

- Korisnici usluga karate kluba „Yu Karate Do“ predstavljaju značajnu odrednicu valorizacije njegovog rada, s obzirom da kroz svoje stavove i mišljenja iskazuju vrlo precizne i eksplicitne stavove o pojedinim činionicima sistema usluga i rada kluba;

- Korisnici usluga kluba svojim vrednovanjem pojedinih indikatora pružaju veoma jasne informacije menadžmentu na kojim tačkama svojih aktivnosti treba u budućnosti da posvete mnogo više pažnje, kako bi unapredili sistem usluga u klubu (to se u konkretnom slučaju, u prvom redu, odnosi na karakteristike prostora u kojem klub realizuje svoje aktivnosti, higijenu sanitarnih prostorija, kao i marketinške aktivnosti organizacije u celini);

- Kriterijume uspešnosti svake sportske usluge u karate klubu neophodno je posmatrati kroz odnos – koliko je „isporučena“ usluga ispunila očekivanja neposrednih korisnika. Mada očekivanja aktivnih korisnika mogu biti pod uticajem različitih faktora (modnih trendova, sportske standardizacije, individualnih ciljeva, i sl.), njihovo kreiranje percepcije same usluge, kao i njene vrednosti, događa se na individualnom nivou korisnika;

- Za menadžment karate kluba je zato veoma bitna spoznaja o tome da je najznačajniji faktor organizacijske i uslužne uspešnosti - zadovoljan korisnik (a zadovoljan korisnik je samo onaj koji je korišćenjem konkretne sportske usluge, u konkretnom klubu, ispunio svoja očekivanja). U ovakvom kontekstu su analizirani rezultati istraživačkog prostora kojim su detektovani indikatori - u kojoj su meri i čime ispitanici zadovoljni, odnosno nezadovoljni, kada je reč o sistemu sportskih usluga u klubu „Yu Karate Do“. Distribucije njihovih odgovora omogućile su hijerarhijsko rangiranje (u manifestnom prostoru) pojedinih činilaca iz sistema usluga kluba koje korisnici percipiraju u pozitivnom, odnosno negativnom kontekstu. Sadržajna struktura ovih indikatora uslovlila je diferenciranje po devet karakterističnih elemenata usluge na koje njihovi korisnici u klubu obraćaju najveću pažnju.

Izjava autora

Autori pridonijeli jednako.

Konflikt interesa

Mi izjavljujemo da nemamo konflikt interesa.

factors in the karate club “Yu Karate-Do” is included in the identified research content, among which are the following:

- Service users of the karate club “Yu Karate-Do” represent a significant determinant for evaluation of the club’s work, considering that through their views and opinions, they express very precise and explicit attitudes about certain factors of the club’s service system;

- By their evaluation of specific indicators, the users of the club’s services provide very clear information to the management as to which of the activities they should dedicate much more attention to in the future in order to improve the club’s service system (in the particular case this mainly relates to the characteristics of the area where the club performs its activities, hygiene of sanitary facilities, as well as the marketing activities of the organization as a whole);

- The success criteria for each sport service in a karate club should be regarded through the extent that the expectations of the immediate users were met by a “delivered” service. Although the expectations of active users can be influenced by various factors (fashion trends, sport standardization, individual goals, etc.), their creation of the perception of the service itself, as well as of its values, occurs at the level of individual users;

- A very important realization for the management of a karate club is that the most significant factor of organizational and service performance is - a satisfied customer (and a satisfied customer is only the one who satisfied his/her needs by using a specific sport service in a particular club). In this context, the research results have been analyzed and indicators have been detected – what is the extent of satisfaction and what made respondents satisfied or dissatisfied regarding the sports service system of “Yu Karate-Do” club. The distribution of their responses has enabled hierarchical ranking (in the manifest space) of certain factors from the club’s service system that users perceive in a positive or negative manner. The content structure of these indicators has caused the differentiation of nine characteristic service elements that the club’s customers pay the most attention to.

Authorship statement

The authors have contributed equally.

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KOMPARATIVNA ANALIZA EFIKASNOSTI ŠUTIRANJA U RUKOMETU NA EP 2012. GODINE

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Sažetak: Analizom situacione efikasnosti 47 utakmica u obe faze takmičenja sa Evropskog prvenstva u rukometu održanog 2012. godine u Srbiji utvrđena je situaciona efikasnost šutiranja na gol sa šest pozicija (šut sa 6 m, šut sa 9 m, šut sa 7 m, šut iz prolaza, šut sa krila i šut iz kontra napada), sa napomenom da je svaki šut sa ovih pozicija analiziran kao uspješno šutiranje ili neuspješno šutiranje. Uzorak je bio podijeljen u dvije grupe (pobjeda i poraz). Rezultati deskriptivne statistike su pokazali razlike prosječnih rezultata u svim varijablama između pobjedničkih i poraženih ekipa. Značajnost razlika je provjerena T testom. Utvrđeno je da se prosječni rezultati između pobjedničkih i poraženih ekipa statistički značajno razlikuju u varijablama UBG, PROC, ŠKRUS i Š9MNE, dok ostale utvrđene razlike nisu statistički značajne na ovom nivou zaključivanja.

Glavne riječi: rukomet, šutiranje, pogodak, T – test.

Uvod

Polazeći od cilja rukometne igre, po kome je potrebno loptu ubaciti više puta u protivnički gol, nego što će to uraditi sportski protivnik, onda se samo od sebe nameće pitanje kako to najefikasnije uraditi. Pošto je rukomet sa pozicije strukture kretanja i strukture situacije, jedna od najsloženijih ekipnih igara kojom dominiraju brze transformacije iz akcije u akciju (Mikić i Alić Partić, 2002), onda je situacijska efikasnost jedan od bitnih prediktora konačnog rezultatskog uspjeha u rukometu. Svaka utakmica je specifična manifestacija svih sposobnosti, osobina, znanja i ostalih karakteristika sportaša, ali i trenera i ostale prateće logistike (Grujić, Vuleta i Milanović, 2006). Svaka sportska grana, pa i rukomet ima svoju jedinstvenu strukturu faktora koji utiču na sportski rezultat u njemu. Pojedinačni uticaj tih faktora rješavamo preko jednačine specifikacije uspjeha u sportu. Važno je da su faktori uspjehnosti u sportu definirani hijerarhijski, što znači da na početku niza stoje najvažniji faktori ili dimenzije, a na kraju oni

A COMPARATIVE ANALYSIS OF SHOOTING EFFICIENCY IN HANDBALL AT EURO 2012

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Abstract: The analysis of the situational efficiency in 47 matches in both phases of the competition at the European Handball Championship held in 2012 in Serbia determined the situational efficiency in shooting on goal from six positions (six-meter shot, nine-meter shot, seven-meter shot, a pass shot, wing shot and counterattack shot), noting that every shot from these positions has been analyzed either as a success or failure. The sample has been divided into two groups (victory and defeat). Results of descriptive statistics showed differences in average results in all variables between successful and unsuccessful teams. The significance of differences has been tested by T test. It has been found that the average scores between successful and unsuccessful teams differ significantly in variables: (UBG, PROC, ŠKRUS contrite and Š9MNE), while other identified differences are not statistically significant at this level of reasoning.

Key words: handball, shooting, score, T – test.

INTRODUCTION

Given the aim of handball game, according to which it is necessary to throw the ball into an opponent's goal more times than they will, an important question arises: how to do it most efficiently. When it comes to the structure of movement and structure of the situation, handball is one of the most complex team games dominated by rapid transformation from one action to another (Mikić & Alic Partic, 2002), and thus the situational efficiency is one of the most important predictors of the final score successes in handball. Every game is a specific manifestation of all abilities, traits, skills and other characteristics of athletes, as well as coaches and other supporting logistics (Grujić, Vuleta & Milanovic, 2006). Every sport, including handball, has its own unique structure of factors which affect its results. The individual impact of these factors is solved with the specification equation of success in sport. It is important that the factors of success in sport are defined hierarchically, which means that the most important factors or dimensions are at the begin-

koji su manje važni (Milanović, 2009). Neki autori po Vuleta, Sertić i Milanović (2004) ove faktore od kojih zavisi uspješnost u rukometu posmatraju kroz piramidu sastavljenu od četiri nivoa. Upravo po njima treći nivo sačinjava situacijska efikasnost rukometaša. Prikupljanje, odnosno kvantifikacija objektivnih pokazatelja situacione efikasnosti u rukometu, a i u ostalim sportskim igrama čest je predmet interesovanja toretičara iz primjenjene kineziologije. Sama rukometna utakmica je veliki izvor ustaljenih i nepredvidivih situacija koje se mogu bilježiti, a poslije i analizirati sa različitih aspekata. Ovakva praksa, ranije je uvedena u košarci (Trninić, 1995; Dežman i Tkalčić, 2002), odbojci (Janković, Marelić i Milanović, 1991; Marelić, 1994), i u nekim drugim sportovima pa tek onda i u rukometu (Vuleta i Šimenc, 1989; Šimenc, Vuleta, Butorac, Jerković i Blašković, 1996.; Rogulj 2000.; Srhoj, Rogulj, Padovan i Katić, 2001.). Korištenjem odgovarajućih matematičko statističkih algoritama ovako prikupljeni podaci se obrađuju i koriste u predviđanju konačnih rezultata rukometne utakmice. Pošto se Evropska rukometna prvenstva održavaju svake dvije godine to je jedinstvena prilika da se najkvalitetniji igrači i reprezentacije analiziraju u međusobnim utakmicama sa različitih aspekata. Takva analiza je i sadržaj ovog rada.

Cilj ovog istraživanja je utvrđivanje razlika situacione efikasnosti šutiranja na gol reprezentacija učesnica EP u rukometu 2012. godine.

METODE RADA

Uzorak entiteta

Podaci za ovaj rad prikupljeni su sa 39 utakmica Evropskog prvenstva u rukometu održanog u Srbiji od 15 – 29 Januara 2012. godine. Na ovom prvenstvu ukupno je odigrano 47 utakmica, ali je 8 utakmica u prvoj fazi završeno neriješeno pa ove utakmice nisu uzete u analizu. Uzorak entiteta čini 16 reprezentacija, koje su bile raspoređene u četiri grupe:

Uzorak varijabli

Za ovo istraživanje prikupljeno je 15 varijabli koje dobro procjenjuju situacijsku efikasnost šutiranja na gol:

1. Ukupan broj golova – UBG,
2. Broj šuteva – BRŠUT,
3. Procenat uspješnosti - %,
4. Šut sa 7 m uspješno – Š7MUS,
5. Šut sa 7 m neuspješno – Š7MNE,
6. Šut sa 6 m uspješno – Š6MUS,
7. Šut sa 6 m neuspješno – Š6MNE,
8. Šut sa krila uspješno – ŠKRUS,
9. Šut sa krila neuspješno – ŠKRNE,

ning of the series, and those less important are at the end (Milanovic, 2009). According to Vuleta, Sertic & Milanovic (2004), some authors observe these factors that determine success in handball as a pyramid composed of four levels. To them, the third level is comprised of handballer's situational efficiency. Collection or quantification of objective indicators of situational efficiency in handball, as well as in other sports games is a frequent topic of interest to applied kinesiology theorists. A handball match in its own is a great source of established and unpredictable situations that can be recorded and later analyzed from various aspects. This practice has been previously introduced in basketball (Trninić, 1995; Dezman & Tkalčić, 2002.), volleyball (Jankovic, Marelić & Milanovic, 1991; Marelić, 1994), in some other sports, and then in handball (Vuleta & Simenc, 1989; Simenc, Vuleta, Butorac, Jerkovic & Blaskovic, 1996; Rogulj 2000; Srhoj, Rogulj, Padovan & Katic 2001). By using the appropriate mathematical statistical algorithms, information obtained in this way are processed and used in predicting the final results of a handball match. As the European Handball Championships are held every two years, it is a unique opportunity to analyze the best players and teams in mutual matches from different aspects. Such analysis is the content of this paper.

The aim of this research is to determine the differences in situational efficiency in shooting for a goal from the part of the teams competing at the European Handball Championship in 2012.

METHODS

The sample of entities

Data for this study were collected from 39 matches of the European Handball Championship held in Serbia from January 15-29, 2012. At this championship, a total of 47 matches has been played, but 8 matches in the first phase ended in a draw, so these games were not included in the analysis. The sample of entities consists of 16 teams, which were assigned to four groups.

The sample of variables

15 variables that accurately assess situational efficiency in shooting on goal have been collected for the purposes of this study:

1. A total number of goals - UBG,
2. A number of shots - BRŠUT,
3. The percentage of success -%
4. A successful seven-meter shot - Š7MUS,
5. An unsuccessful seven-meter shot - Š7MNE,
6. A successful six-meter shot - Š6MUS,
7. An unsuccessful six-meter shot - Š6MNE,
8. A successful wing shot - ŠKRUS

10. Šut iz prolaza uspješno – ŠPRUS,
11. Šut iz prolaza neuspješno – ŠPRNE,
12. Šut iz kontra napada uspješno – ŠKNUS,
13. Šut iz kontra napada neuspješno – ŠKNNE,
14. Šut sa 9 m uspješno – Š9MUS,
15. Šut sa 9 m neuspješno – Š9MNE

METODE OBRADE PODATAKA

Prikupljeni podaci su analizirani sa aspekta frekvencije šutiranja sa posmatranih pozicija i sa aspekta uspješnosti odnosno neuspješnosti šutiranja. Pošto su ekipe koje su ušle u analizu podijeljene u grupe pobjednika i poraženih, utvrđene razlike aritmetičkih sredina i značajnost te razlike testirali smo T – testom za velike nezavisne uzorke. Obrada podataka je izvršena programskim paketom SPSS 15.

REZULTATI I RASPRAVA

U tabeli br. 1 prikazani su prosječni rezultati posmatranih varijabli za pobjedničke i poražene ekipe na ovom takmičenju. Uočavaju se brojčane razlike aritmetičkih sredina analiziranih varijabli između posmatranih grupa. Na ovom prvenstvu pobjedničke i poražene ekipe su prosječno imale približno isti broj šuteva na gol (46,87 pobjedničke i 46,56 poražene). Pobjedničke ekipe su prosječno po odigranoj utakmici postizale 28,62 gola, a poražene 25,18 golova, uz različite procenete uspješnosti (61,31 % za pobjedničke, a 54,36 % poražene). Ovakva procentualna situacijska efikasnost pobjedničkih ekipa je skladu sa savremenim trendovima rukometa. Ako ovu situacijsku uspješnost uporedimo sa situacijskom uspješnošću Hrvatske rukometne reprezentacije na SP 2013. godine koja je imala 61,43 % situacijske uspješnosti (Vuleta, 2013) i situacijske efikasnosti iste reprezentacije na 20. Svjetskom prvenstvu na kome je procenat situacijske uspješnosti iznosio 62 % (Perkovac i sur., 2009), te kompletne uspješnosti na EP 2000. godine (63,92 %) i SP 2003 sa (56,81 %) dobijamo jasnu predstavu na kom nivou uspješnosti napadači u savremenom rukometu trebaju da šutiraju. Prosječna frekvencija uspješnog šutiranja na gol sa pozicije sedam metara (Š7MUS) je na strani pobjedničkih ekipa. Ovakav podatak nam govori da su pobjedničke ekipe raspolagale sa tehničko – taktički kvalitetnijim rukometašima, koji su koristeći svoju prednost češće sticali taktičku prednost nad igračima odbrane i time ih primoravali da prave prekršaje koji su se kažnjavali sedmercem. Porazene ekipe su imale više neuspješnih šuteva na gol (Š7MNE) sa ove pozicije. Veoma slične prosječne vrijednosti su obe grupe postigle u varijabli (Š6MUS). Poznavajući karakteristike ove pozicije

9. An unsuccessful wing shot - ŠKRNE
10. A successful pass shot - ŠPRUS,
11. An unsuccessful pass shot- ŠPRNE
12. A successful counterattack shot - ŠKNUS,
13. An unsuccessful counterattack shot - ŠKNNE,
14. A successful nine-meter shot - Š9MUS,
15. An unsuccessful nine-meter shot - Š9MNE

DATA PROCESSING METHODS

The collected data have been analyzed with respect to the frequency of shooting from the observed positions, as well as in terms of its success or failure. Since the teams which entered the analysis have been divided into groups of winners and losers, the determined differences of arithmetic means and their significance have been tested with a T - test for large independent samples. Data analysis was performed with SPSS 15 software package.

RESULTS AND DISCUSSION

Table 1 shows the average results of the observed variables for the winning and defeated teams in the competition. Among these groups, the numerical differences in arithmetic means of the analyzed variables have been noticed. Both winning and losing teams at this championship had in average about the same number of shots on goal (46.87 the winning teams, and 46.56 the defeated). The winning teams in average scored 28.62 goals per game, and the defeated 25.18 goals, with different percentages of efficacy (61.31% winning, and 54.36% the defeated). This percentage of the winning teams' situational efficiency is consistent with modern trends in handball. If this situational efficiency is compared with situational efficiency of the Croatian handball team at the World Championships in 2013, which had 61.43% of situational efficiency (Vuleta, 2013), the situational efficiency of the same team at the 20th World Championships where it was 62% (Perkovac et al., 2009), the total efficiency at the European Championship in 2000 (63.92%), and World Championship in 2003 (56.81%), we get a clear picture on what level of efficiency modern handball shooters need to shoot. The average frequency of efficient shooting on goal from a seven-meter position (Š7MUS) is on the side of the victorious teams. This information tells us that the winning teams had technically and tactically better handball players, who gained a tactical advantage more often using their advantage over the defence players, and thus forced them to commit fouls in order to get a seven-meter penalty shot. The defeated teams had several unefficient shots on goal (Š7MNE) from this position. Both groups have achieved

(udaljenost od gola, ugao šutiranja, fizičke predispozicije igrača) i tehnike šutiranja reprezentativaca ovakvi rezultati šutiranja su bili za očekivati. Nešto slabije prosječne vrijednosti u varijabli (Š6MNE) imale poražene ekipe. Ovakvu situaciju možda možemo pripisati kvalitetu golmana pobjedničkih ekipa. Evidentna razlika prosječnih vrijednosti u varijabli (ŠKRUS) je na strani pobjedničkih ekipa koje su uspješno šutirale sa ovih pozicija u prosjeku 5,27 puta po utakmici, dok su poražene ekipe sa iste pozicije u prosjeku imale 4,26 uspješna šuta. Varijabla koja prikazuje neuspješne šuteve sa ove pozicije (ŠKRNE) pokazuje veće prosječne vrijednosti kod poraženih ekipa 3,62 u odnosu na pobjedničke 3,54. Ovakvi pokazatelji govore da su poražene ekipe imale više neuspješnih šutiranja sa krilnih pozicija. Ukupna prosječna efikasnost šutiranja sa krilnih pozicija na ovom prvenstvu iznosi 58,96 %, što je za samo 1,04 % slabije od očekivane uspješnosti koja za ovakvo takmičenje iznosi oko 60 % (Czerwinski i Seco po Vuleti, 2003). Poznavajući karakteristike šutiranja sa krilnih pozicija, sa pravom možemo da kažemo da ovi igrači moraju da imaju veoma dobru tehniku šutiranja i odlične motoričke predispozicije. Ove navode potvrđuje (Vuleta, 2013) podacima da su krilni igrači reprezentacije Hrvatske na SP 2013. imali 71,71 % uspješnosti šutiranja sa krila. Prosječne vrijednosti rezultata u varijablama (ŠPRUS i ŠPRNE) su više kod poraženih ekipa. Vjerovatno su poražene ekipe u nedostatku kolektivnih rješenja u fazi napada više forsirale individualnu igru svojih tehnički najboljih igrača, pa iz toga u prosjeku imaju veći broj uspješnih pokušaja poslije prolaza, a isto tako imaju manji broj pogrešnih pokušaja prilikom šutiranja sa ove pozicije. Drugačiji odnosi su u prosječnim vrijednostima rezultata ekipa u varijablama (ŠKNUS i ŠKNNE) gdje su uspješnije bile pobjedničke ekipe. Varijable (Š9MUS i Š9MNE) prikazuju prosječne rezultate u šutiranju sa vanjskih pozicija. Bolje prosječne rezultate pokazuju pobjedničke ekipe. Pobjedničke ekipe su sa ovih pozicija imale 41,99 % uspješnosti a poražene 36,49 %. Sve ekipe na ovom prvenstvu su u prosjeku sa ovih pozicija imale manju efikasnost 38,88 % u odnosu na očekivanu od oko 50 % (Vuleta, 2003). Kvalitetniju realizaciju šutiranja sa vanjskih pozicija imaju vanjski napadači reprezentacije Hrvatske na SP 2013 i ona iznosi 55,42 % (Vuleta, 2013).

very similar average values of variable (Š6MUS). Knowing the characteristics of this position (distance from the goal, shooting angle, players' physical qualities) as well as representatives' shooting techniques, such shooting results were expected. The defeated teams had slightly lower average values of the variable (Š6MNE). This situation may be attributed to the quality of winning teams' goalkeepers. An apparent difference in average values of the variable (ŠKRUS) is on the side of the winning teams who have successfully shot from these positions, in average 5.27 times per game, while the defeated teams had 4.26 successful shots in average from the same position. These indicators show that the defeated teams had several unsuccessful shots from the wing positions. The total average shooting efficiency from the wing positions is 58.96% in this championship, which is only 1.04% lower than the expected efficiency, but which is about 60% for such a competition (Czerwinski and Seco according to Vuleta, 2003). Knowing the characteristics of shooting from the wing positions, we can rightfully say that these players have to have a very good shooting technique and excellent motor predispositions. These claims were confirmed by (Vuleta, 2013) with the data that Croatian national team wingers had a 71.71% shooting efficiency from wing positions at the World Cup 2013. Average values of the results in variables (ŠPRUS i ŠPRNE) are higher in the defeated team. The defeated teams have probably forced the individual game of their technically better players in the absence of collective solutions in the attack phase, and thus in average have a greater number of successful attempts after a pass, as well as a smaller number of wrong attempts when shooting from this position. There are different relationships in average values of results in the team variables (ŠKNUS and ŠKNNE), where the winning teams were more successful. The variables (Š9MUS and Š9MNE) show average results in shooting from the external positions. The winning teams show better average results. The winning teams had 41.99% of efficiency from these positions, while the defeated had 36.49%. All teams at this championship in average had lower efficiency 38.88% from these positions, in relation to the expected of about 50% (Vuleta, 2003). External attackers in Croatian national team at the World Championships in 2013 had a better realization of shooting from the external positions, which is 55.42% (Vuleta, 2013).

Tabela 1. Prosječni rezultati pobjedničkih i poraženih ekipa

| VARIJABLE / / VARIABLES | Mean POB. | Mean POR. |
|----------------------------|--------------|--------------|
| UBG | 28,62 | 25,18 |
| BRŠUT | 46,87 | 46,56 |
| PROC | 61,31 | 54,36 |
| Š7MUS | 3,08 | 2,36 |
| Š7MNE | ,69 | 1,13 |
| Š6MUS | 5,13 | 5,10 |
| Š6MNE | 2,56 | 2,70 |
| ŠKRUS | 5,72 | 4,26 |
| ŠKRNE | 3,54 | 3,62 |
| ŠPRUS | 2,95 | 3,10 |
| ŠPRNE | ,87 | ,59 |
| ŠKNUS | 4,69 | 3,56 |
| ŠKNNE | 1,36 | 1,54 |
| Š9MUS | 7,05 | 6,79 |
| Š9MNE | 9,74 | 11,82 |

Legenda: UBG – ukupan broj golova, BRSUT – broj šutiranja, PROC – procenat uspješnosti, S7MUS – šut sa 7 m uspješno, S7MNE – šut sa 7 m ne uspješno, S6MUS – šut sa 6 m uspješno, S6MNE – šut sa 6 m ne uspješno, SKRUS – šut sa krila uspješno, SKRNE – šut sa krila ne uspješno, SPRUS – šut iz prolaza uspješno, SPRNE – šut iz prolaza ne uspješno, SKNUS – šut iz kontra napada uspješno, SKNNE – šut iz kontra napada ne uspješno, S9MUS – šut sa 9 m uspješno, S9MNE – šut sa 9 m ne uspješno

Značajnost utvrđenih razlika aritmetičkih sredina analiziranih varijabli provjerena je T testom za velike nezavisne uzorke.

Tabela 2. Značajnost razlika između aritmetičkih sredina

| Varijabla | M (pobjedničke) / / (winners) | M (poražene) / / (the defeated) | t | p |
|-----------|----------------------------------|------------------------------------|-------|------|
| UBG | 28,62 | 25,18 | 3,45 | ,001 |
| BRŠUT | 46,87 | 46,56 | -,39 | ,697 |
| PROC | 61,31 | 54,36 | 4,18 | ,000 |
| Š7MUS | 3,08 | 2,36 | 1,52 | ,132 |
| Š7MNE | ,69 | 1,13 | -1,70 | ,088 |
| Š6MUS | 5,13 | 5,10 | ,45 | ,651 |
| Š6MNE | 2,56 | 2,70 | -1,00 | ,292 |
| ŠKRUS | 5,72 | 4,26 | 2,11 | ,037 |
| ŠKRNE | 3,54 | 3,62 | -,38 | ,704 |
| ŠPRUS | 2,95 | 3,10 | ,29 | ,767 |
| ŠPRNE | ,87 | ,59 | 1,07 | ,286 |
| ŠKNUS | 4,69 | 3,56 | 1,30 | ,196 |
| ŠKNNE | 1,36 | 1,54 | -1,03 | ,303 |
| Š9MUS | 7,05 | 6,79 | ,36 | ,719 |
| Š9MNE | 9,74 | 11,82 | -2,26 | ,026 |

Legenda: UBG – ukupan broj golova, BRSUT – broj šutiranja, PROC – procenat uspješnosti, S7MUS – šut sa 7 m uspješno, S7MNE – šut sa 7 m ne uspješno, S6MUS – šut sa 6 m uspješno, S6MNE – šut sa 6 m ne uspješno, SKRUS – šut sa krila uspješno, SKRNE – šut sa krila ne uspješno, SPRUS – šut iz prolaza uspješno, SPRNE – šut iz prolaza ne uspješno, SKNUS – šut iz kontra napada uspješno, SKNNE – šut iz kontra napada ne uspješno, S9MUS – šut sa 9 m uspješno, S9MNE – šut sa 9 m ne uspješno, M – Aritmetička sredina, t – t-test, p – nivo statističke značajnosti

Table 1. Average results of the winning and the defeated teams

The significance of the differences in arithmetic means of the analyzed variables was tested with T test for large independent samples.

Table 2. The significance of the differences in arithmetic means

S9MNE – an unsuccessful nine-meter shot, M – an arithmetic mean, t – t-test, p – the level of statistical significance

Legend: UBG - the total number of goals, BRSUT – the number of shots, PROC – percentage of efficiency, S7MUS – a successful seven-meter shot, S7MNE – an unsuccessful seven-meter shot, S6MUS – a successful six-meter shot, S6MNE – an unsuccessful six-meter shot, SKRUS – a successful wing shot, SKRNE – an unsuccessful wing shot, SPRUS – a successful pass shot, SPRNE – an unsuccessful pass shot, SKNUS – a successful counterattack shot, SKNNE – an unsuccessful counterattack shot, S9MUS – a successful nine-meter shot, S9MNE – an unsuccessful nine-meter shot.

Legend: UBG - the total number of goals, BRSUT – the number of shots, PROC – percentage of efficiency, S7MUS – a successful seven-meter shot, S7MNE – an unsuccessful seven-meter shot, S6MUS – a successful six-meter shot, S6MNE – an unsuccessful six-meter shot, SKRUS – a successful wing shot, SKRNE – an unsuccessful wing shot, SPRUS – a successful pass shot, SPRNE – an unsuccessful pass shot, SKNUS – a successful counterattack shot, SKNNE – an unsuccessful counterattack shot, S9MUS – a successful nine-meter shot, S9MNE – an unsuccessful nine-meter shot, M – an arithmetic mean, t – t-test, p – the level of statistical significance

Rezultati T testa pokazuju da su razlike između aritmetičkih sredina u varijablama: (UBG, PROC, ŠKRUS i Š9MNE) statistički značajne na ovom nivou zaključivanja. Ostale utvrđene razlike aritmetičkih sredina nisu statistički značajne. Na osnovu ovih pokazatelja možemo zaključiti da se pobjedničke i poražene ekipe sa ovog prvenstva najviše razlikuju u ove četiri varijable. Ovakve rezultate objašnjavamo velikom ujednačenošću ekipa čiji su pokazatelji uzeti u analizu. Pošto se radi o najboljim Evropskim ekipama ovakvi rezultati su u granicama očekivanog. Sa druge strane je evidentno da su igrači ekipa, koji najčešće šutiraju sa ovih pozicija, a i vratari različitih tehničko taktičkog kvaliteta.

Posmatranje parametara situacione uspješnosti pojedinih rukometaša, a i ekipe u cjelini je jedan od nezaobilaznih faktora u analizi napretka svakog igrača, kao i ekipe u cjelini. Isto tako ovi parametri mogu poslužiti rukometnim trenerima u odabiru taktike i koncepcije igre, kao i u pripremi ekipe za neku utakmicu ili takmičenje.

ZAKLJUČAK

Rezultati ove analize su pokazali da se situacijska efikasnost igrača na ovom prvenstvu razlikuje između pobjedničkih i poraženih ekipa. Kod većine analiziranih varijabli primijećene su razlike prosječnih rezultata između pobjedničkih i poraženih ekipa, dok su razlike u četiri varijable statistički značajne na blažem kriteriju zaključivanja. One ekipe koje svoju situacijsku efikasnost podignu iznad 50% mogu sa pravom očekivati optimalne rezultate, pod uslovom da i ostali faktori budu na zavidnom nivou. Naravno da jedno turnirsko takmičenje ima sasvim drugačiji karakter od jedne utakmice, pa je rezultate ove analize potrebno tumačiti u tom pravcu. Rukometni treneri neke pokazatelje mogu iskoristiti u komparaciji uspješnosti sopstvene ekipe sa ekipama koje predstavljaju Evropski rukometni vrh.

Posmatranje parametara situacione uspješnosti pojedinih rukometaša, a i ekipe u cjelini je jedan od nezaobilaznih faktora u analizi napretka svakog igrača, kao i ekipe u cjelini. Isto tako ovi parametri mogu poslužiti rukometnim trenerima u odabiru taktike i koncepcije igre, kao i u pripremi ekipe za neku utakmicu ili takmičenje.

Izjava autora
Autori pridonijeli jednako.

Konflikt interesa
Mi izjavljujemo da nemamo konflikt interesa.

T test results showed that the differences in arithmetic means in variables: (UBG, PROC, ŠKRUS and Š9MNE) are statistically significant at this level of reasoning. Other established arithmetic means differences are not statistically significant. Based on these indicators, we can conclude that the winning and the defeated teams from this championship mostly differ in these four variables. These results are explained by high uniformity of the teams whose indicators are included into analysis. Since these are the best European teams, such results are within the expected limits. On the other hand, it is obvious that the players, who usually shoot from these positions, as well as the goalkeepers, differ in technical and tactical quality. The observation of situational efficiency parameters of certain handball players, as well as a team as a whole, is one of the indispensable factors in the analysis of the progress of each player and the team as a whole. Furthermore, these parameters can be useful to handball coaches in the selection of tactics and game concepts, as well as in the preparation of the team for a match or competition.

CONCLUSION

The analysis of results showed that the situational efficiency of players at this championship varies between successful and unsuccessful teams. In most of the analyzed variables, we have noticed differences in average results between successful and unsuccessful teams, while the differences in the four variables are statistically significant at the lenient criterion of reasoning. Those teams who raise their situational efficiency above 50% can rightfully expect optimal results, provided that other factors are at a high level as well. Of course that one tournament competition has a completely different character than a single game, so the results of this analysis should be interpreted in that light. Handball coaches can use some indicators to compare the efficiency of their team with the teams which are at the top of European handball. The observation of situational efficiency parameters of certain handball players, as well as a team as a whole, is one of the indispensable factors in the analysis of the progress of each player and the team as a whole. Furthermore, these parameters can be useful to handball coaches in the selection of tactics and game concepts, as well as in the preparation of the team for a match or competition.

Authorship statement
The authors have contributed equally.

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We declare that we have no conflicts of interest.

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MULTIMEDIJSKI PRISTUP ODREĐIVANJU GRANIČNIH VRIJEDNOSTI ELEMENATA ŽIVOTNE SREDINE SA ASPEKTA UTICAJA NA ZDRAVLJE SPORTISTA

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Sažetak: Analizirani su nedostaci današnjeg monomedijskog pristupa određivanja graničnih koncentracija zagađenja medija životne sredine (vazduh, voda, hrana) sa aspekta uticaja na zdravlje sportista. Na primjeru zagađenja živom u dva geografska područja pokazana je nekonzistentnost i neekonomičnost ocjene ugroženosti sportista ako su granične vrijednosti donešene u postupku za svaki medij posebno, a na primjeru zagađenja vazduha, vode i hrane fenolom dokazuje se da se u različitim područjima mogu primjenjivati različite granične koncentracije za istu materiju u istom mediju uz primjenu multimedijskog pristupa određivanju graničnih vrijednosti.

Ključne riječi: sportista, životna sredina, živa, fenol.

Uvod

Cilj utvrđivanja najvećeg broja graničnih vrijednosti elemenata životne sredine je dati osnovu za zaštitu zdravlja, kako osoba koje se bave sportom rekreativno, tako i profesionalnih sportista, od negativnih učinaka izloženosti tim elementima. Te se granične vrijednosti odabiru tako da je mala vjerovatnoća negativnih zdravstvenih učinaka uz nivoe izloženosti ispod tih vrijednosti. Negativni učinak na zdravlje sportista se u tom kontekstu najčešće definiše kao poremećaj fizioloških funkcija ili nastajanje patoloških promjena koje utiču na normalno funkcionisanje organizma ili koje mogu doprinijeti smanjenoj sposobnosti organizma da se zaštiti od dodatnog opterećenja (Đukić, 2008).

Granične vrijednosti se najčešće donose na osnovu pretpostavke zanemarivog ili prihvatljivog rizika za organizam čovjeka. Rizik je statistički koncept. Ocjenjuje se na osnovu odnosa nivoa izloženosti i intenziteta učinka („exposure-effect“) ili nivoa izloženosti i učestalosti učinka („exposure-response“), odnosno doze i učinka („dose-response“, „dose-effect“).

MULTIMEDIA APPROACH TO DETERMINATION OF ENVIRONMENTAL EXPOSURE LIMITS FROM THE ASPECT OF IMPACT ON THE HEALTH OF SPORTSMEN

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Abstract: Weaknesses of the current monomedium approach to determination of environmental exposure limits (air, water, food), from the aspect of impact on the health of sportsmen were analyzed. Applying the example of mercury pollution in two geographical areas, one could find inconsistency and inefficiency of the assessment of the sportsmen vulnerability if the exposure limits were made in the proceeding for each medium separately, while in the example of pollution of air, water and food with phenol it is proven that different limit concentration may be applied in different area for the same elements in the same medium applying the multimedia approach to determination of the limit values.

Key words: sportsmen, environment, mercury, phenol

INTRODUCTION

The purpose of determination of the most limit values of the environmental elements is to give the base for the health protection, both for the persons going in for sports for recreational purposes and professional sportsmen, from the negative effects caused by exposure to those elements. Such limit values are chosen in a way that there is small probability of the negative health effects along with the level of exposure below those values. The negative impact on the sportsmen health is, in that context, mostly defined as disorder of physiological functions or occurrence of pathological changes which affect normal functioning of the body or which may contribute to the reduced body capacity to be protected from the additional burdening (Djukic, 2008).

The limit values are mostly made based on the assumptions of negligible or acceptable risk for the body. The risk is the statistical concept. It is assessed based on the exposure level and exposure-effect or the exposure level and exposure-response, namely “dose-response” and “dose-effect”.

Razlikuju se dvije vrste učinaka:

- učinci s graničnim vrijednostima („threshold effects“), tj. učinci intenzitet, odnosno učestalost koji pada sa smanjenjem izloženosti, odnosno doze, i koji se najčešće smanje na nulu prije nego je nivo izloženosti, odnosno doza, došla do nule (nivo izloženosti je postigao graničnu vrijednost ispod koje nema učinka),
- učinci bez graničnih vrijednosti („non-threshold effects“), tj. učinci kod kojih nema granične vrijednosti, tj. nema tako niskog nivoa izloženosti koja ne bi mogla izazvati učinak (bilo koja izloženost može izazvati učinak; npr. karcinogeni učinci na osnovi genotoksičnosti).

Granične vrijednosti za prvu vrstu učinaka dobivaju se iz krivulja izloženosti doze i učinka iz kojih se ocjenjuje NOAEL („no-observed-adverse-effect-level“, „nivo izloženost bez učinka“). Taj se nivo najčešće dobiva na osnovu eksperimenata na životinjama, ali se može dobiti i epidemiološkim ispitivanjima na sportistima. Danas se granične vrijednosti donose za svaki medij životne sredine nezavisno, praktično ne uzimajući u obzir prisutnost iste zagađujuće materije u drugim medijima životne sredine (Peirce, 1999).

NAJČEŠĆI UTICAJI ELEMENATA ŽIVOTNE SREDINE NA ZDRAVLJE SPORTISTA

Veliki je broj elemenata životne sredine koji mogu prouzrokovati promjene u funkciji organizma sportiste. Pojednostavljen pregled najčešćih promjena prikazan je u tabelama 1-3 (Valić, 2001).

U tabeli 1. prikazani su učinci najčešćih zagađenja koja djeluju na zdravlje ljudi koji se bave različitim vidovima sportskih aktivnosti.

Tabela 1. Zagađenje atmosfere

| Elementi / Elements | Učinci / Effects |
|--|---|
| Oksidi sumpora / Sulfur oxide | Pogoršanje astme i hroničnog bronhitisa / Relapse of asthma and chronic bronchitis Smanjenje plućne funkcije / Reduction of the pulmonary function Nadražaj sluznice nosa i oka / Irritation of the nose and eye mucous membrane |
| Oksidi sumpora uz atmosferske čestice / Sulfur oxide along with the atmosphere particles | Dodatni uticaj u razvoju hroničnog bronhitisa i emfizema / Additional impact in development of the chronic bronchitis and emphysema Bolesti dišnih organa mlađih kategorija / Illnesses of respiratory organs of younger categories Pogoršanje bronhitisa i kardiovaskularnih bolesti / Relapse of bronchitis and cardiovascular diseases Dodatni uticaj u nastanku raka pluća / Additional impact in the development of lung cancer |
| Oksidanti / Oxidants | Pogoršanje emfizema, astme i bronhitisa / Relapse of emphysema, asthma and bronchitis Smanjenje plućne funkcije / Reduction of the pulmonary function Nadražaj očiju i dišnog sistema / Irritation of eyes and respiratory system |
| Ugljen monoksid / Carbon monoxide | Povećan opšti mortalitet i mortalitet od koronarne bolesti / Increased general mortality and mortality caused by the coronary diseases Uzročni faktor ateroskleroze / Causative factor of atherosclerosis |
| Olovo / Lead | Posljedice kumulativnog djelovanja (oštećenje eritropoeze, perifernog i središnjeg živčanog sistema) / Consequences of the cumulative acting (deterioration of erythropoiesis, peripheral and central nervous system) |
| Kadmij / Cadmium | Oštećenje pluća, jetre i bubrega / Deterioration of lungs, liver and kidneys |
| Živa / Mercury | Oštećenje živčanog sistema / Deterioration of the nervous system |
| Fluoridi / Fluorides | Uticaj na zube i kosti / Impact on teeth and bones |
| Azbest / Asbestos | Kalcifikacija pleure, karcinom bronha / Calcification of pleura, cancer of bronchi |

There are two types of effects:

- The threshold effects, i.e. the intensity effects, namely the frequency which is falling down with the reduced exposure, namely the dose, and which are most frequently brought to the zero before the exposure level, namely the dose reaches zero (the exposure level reached the limit value below which there are no effects),
- The non-threshold effects, i.e. the effects without limit values, namely there is no such a low level of the exposure which might cause the effect (any exposure may cause the effect, e.g. the cancerogenic effects based on gene toxicology)

The limit values for the first type of effects are obtained from the curve of the dose-response and dose-effect and the effects from which NOAEL (“no-observed-adverse-effect-level”, “exposure level without effects”). Such a level is mostly obtained based on experiments with animals, but it may also be obtained applying the epidemiological testing with sportsmen. The limit values are nowadays made for each medium of the environment independently, practically not taking into account the presence of the same polluting matter in other environmental medium (Peirce, 1999).

THE MOST FREQUENT IMPACT OF THE ENVIRONMENTAL ELEMENTS ON THE SPORTSMEN LIFE

There are a lot of environmental elements which may cause changes in the function of the sportsmen body. The simplified overview of the most frequent changes is presented in the Tables 1-3 (Valic, 2001).

In the Table 1, there are the effects of the most frequent pollution which affect the health of people dealing with different types of the sport activities.

Table 1 – Atmosphere pollution

U tabeli 2. navedena su neka zagađenja hrane i vode koja izazivaju zdravstvene učinke kod osoba koje se bave sportskim aktivnostima. Zagađenja vode i hrane još uvijek uzrokuju najveći broj bolesti među svim elementima životne sredine.

Tabela 2. Zagađenja vode i hrane

| Elementi / Elements | Učinci / Effects |
|--|---|
| Bakterije / Bacteria | Gastrointestinalne infekcije (tifus, kolera, šigeloze, salmoneloze) / Gastrointestinal infections (typhus, cholera, shigellosis, salmonellosis) |
| Virusi / Viruses | Hepatitis, konjunktivitis / Hepatitis, conjunctivitis |
| Protozoa i metazoa / Protozoa and metazoan | Amebijaza, shistosomijaza, hidatidoza i dr.parasitske bolesti / Amoebiasis, schistosomiasis, hydatidose, arsenom, chromo |
| Metali / Metals | Otrovanje olovom, živom, kadmijem, arsenom, hromom / Pollution with lead, mercury, cadmium, arsen, chromo |
| Nitrati i nitriti / Nitrates and nitrites | Methemoglobinemija / Methemoglobinemia |
| Nitrozamini / Nitrosamine | Mutageni i karcinogeni učinci / Mutagens and cancerogenic effects |
| Fluoridi / Fluorides | Učinci na zube i kosti / Effects on teeth and bones |
| Nafta, fenoli / Oil, phenols | Smanjena pitkost vode / Reduced water drinkability |

In the Table 2, there is some pollution of food and water which causes the health effects with persons going in for sport activities. Pollution of water and food still causes most of illnesses among all environmental elements.

Table 2. Pollution of water and food

Tabela 3. Zagađenja tla

| Elementi / Elements | Učinci / Effects |
|--|---|
| Ekskreti čovjeka / Excretes of man | Shistosomijaza, tenijaza, ankilostomijaza / Schistosomiasis, teniasis, ankilostomiase |
| Kućni otpad / Household waste | Prisutnost prenosioca bolesti / Presence of the illness transmitters |
| Smeće i prenosioci u smeću / Rubbish and transmitters in the rubbish | Bolesti prenošene glodavcima, bolesti prenošene insektima / Illnesses transmitted by rodents, illnesses transmitted by insects Zagađenje vode i vazduha zbog lošeg odlaganja / Water and air pollution due to bad putting down |
| Industrijski otpad / Industrial waste | Učinci metala i drugih zagađenja preko prehrambenog lanca / Effects of metal and other pollution through the food chain |
| Dubriva / Fertilizers | Zagađenja površinskih i podzemnih voda / Pollution of surface and underground water |
| Pesticidi / Pesticides | Zagađenja vegetacije i ulazak u prehrambene lance / Pollution of vegetation and entrance to the food chain Zagađenja površinskih i podzemnih voda / Pollution of the surface and underground water |

Table 3. Pollution of ground

Zdravlje ljudi koji se bave različitim vidovima sportskih aktivnosti može biti ugroženo neposrednom ingestijom vode ili kroz kožu ili preko hrane. Kako pokazuje tabela 2, najvažniji su biološki elementi koji se unose ingestijom, preko kože ili vektorima, i hemijski elementi koji su najčešće posljedica zagađenja vode industrijskim otpadom (Đukić, 2009).

Hrana se može zagađati u cijelom lancu od sirovinne preko prerade, transporta, skladištenja i raspodjele do rukovanja prilikom priređivanja obroka, a i vodom koja se pri tome upotrebljava. Glavne su grupe biološka zagađenja (posljedica kontakta hrane s bakterijama, virusima, gljivicama, helmintima i protozoima) i hemijska zagađenja (posebno metali, polihlorirani bifenili te organofosforni, organohlorirani i karbamatski pesticidi), ali treba uzeti u obzir i neka prirodna zagađenja kao što su hepatotoksični i karcinogeni aflatoksini koji proizvode neke plijesni.

Zagađenje tla biološkim elementima još uvijek je među važnim uzrocima infekcija u seoskim i poluseo-

Health of the people dealing with different types of sport activities may be jeopardized by direct ingestion of water or through the skin or through the food. As shown in Table 2, the most important are biological elements taken by ingestion, through the skin or vectors and chemical elements which are most frequently the consequence of the water pollution caused by the industrial waste (Djukic, 2009).

The food may be polluted in the whole chain from the raw material, through the processing, transport, storage and distribution to the handling while preparing some meals, and also with water which is used in this process. The main groups are biological pollution (the consequence of the food contact with bacteria, viruses, fungi, helminthes and protozoa) and chemical pollution (especially metals, polychlorinated biphenyl and organic phosphor, organic chlorinated and carbamate pesticide), but one should also take into account some natural pollution such as hepatotoxic and cancerogenic aflatoxin caused by some toxins.

skim područjima u kojima se obavljaju bazne pripreme sportista, pogotovo u slabije razvijenim područjima (shistosomijaza, leptospiroza, antraks, Q groznica, mikoze, tetanus, botulizam), dok je zagađenje tla otrovnim hemikalijama, koje se sve više primjenjuju u poljoprivredi (đubriva i pesticidi) i industriji (otpadni materijal), opasnost za zdravlje sportista u razvijenim zemljama. Glavni elementi zagađenja tla i učinci koje izazivaju prikazani su u tabeli 3. (Đukić, 2013).

PREDMET ISTRAŽIVANJA

Na primjeru žive u glavnim medijima životne sredine pokazujemo nekonzistentnost i nekonmičnost ocjene ugroženosti sportista od zagađenja koja uzrokuju učinke s graničnim vrijednostima, ako su normativi donešeni u postupku za svaki medij posebno (monomedijski pristup).

Kako samo živa koja je ušla u organizam i koja je tamo zadržana može negativno djelovati, izračunata je količina žive koja se dnevno zadržava u organizmu sportiste uz izloženost graničnim koncentracijama u medijima životne sredine (dnevna retencija iz vazduha, vode, hrane- R_{vazduh} , R_{voda} , R_{hrana}).

REZULTATI I RASPRAVA

Pretpostavljen je sportista težine 64 kg koji udiše prosječno 22 m³ vazduha i pije prosječno 3 litre vode dnevno. Najčešće upotrebljavane granične koncentracije za živu su 1μg/m³ za vazduh i 1 μg/L za pitku vodu i 0,02-0,5 μg/g za različite komponente hrane.

Dnevna retencija žive iz vazduha:

R_{vazduh} = granična koncentracija x dnevni udah vazduha x apsorpcija živine pare (80%) = 1μg/m³ x 22 m³ x 0,8 = **17,6 μg**

Dnevna retencija žive iz vode:

R_{vode} = granična koncentracija u pitkoj vodi x prosječna dnevna količina potrošene pitke vode x apsorpcija anorganske žive iz probavnog sistema (<10%) = 1μg/L x 3 L x 0,1 = **0,3 μg**

Dnevna retencija žive iz hrane:

R_{hrane} = zbir umnožaka prosječne dnevne potrošnje hrane biljnog i životinjskog porijekla odrasle osobe i graničnih koncentracija žive u toj hrani x apsorpcija anorganski odnosno organski vezane žive (pretpostavlja se relativna količina anorganski vezane žive u hrani 80%).

U tabeli 4. prikazan je način izračuna dopustivog dnevnog unosa žive hranom. Prosječna dnevna potrošnja uzeta je iz ocjene Međunarodne komisije za radiološku zaštitu na osnovu analiza u sedam geografskih regija.

Ground pollution with biological elements is still among important causes of infections in rural and semi-rural areas in which the base preparation of the sportsmen are carried out, especially in poorly developed areas (schistosomiasis, leptospirosis, anthrax, Q fever, mycosis, tetanus, botulism), while the ground pollution with poisonous chemicals, which are more and more applied in agriculture (fertilizers and pesticides) and industry (waste material), danger for the sportsmen health in developed countries. The main elements of the ground pollution and effects caused are presented in Table 3 (Djukic, 2013)

RESEARCH SUBJECT

Applying the example with mercury in main environmental media, we show the inconsistency and inefficiency of the assessment of the sportsmen vulnerability from pollution causing the threshold effects, provided that the standards were made in the proceeding for each medium separately (mono medium approach).

Having in mind that only the mercury which entered the body and which was kept there may have adverse impact, the amount of mercury which is daily kept in the sportsman body was calculated, along with the exposure to the limit concentrations in the environmental media (daily retention from air, water, food- R_{air} , R_{water} , R_{food}).

RESULTS AND DISCUSSIONS

The assumption is as follows: the sportsman, whose weight is 64 kg who breathes in 22 m³ air on average and drinks 3 l of water on average. The most frequently used limit concentrations for mercury are 1μg/m³ for air and 1 μg/L for drinking water and 0,02-0,5 μg/g for different food components.

Daily retention of mercury from the air:

R_{air} = limit concentration x daily breathe in of air x mercury steam absorption (80%) = 1μg/m³ x 22 m³ x 0,8 = **17,6 μg**

Daily mercury retention from water:

R_{water} = limit concentration in drinking water x average daily amount of the consumed drinking water x absorption of the inorganic mercury from the digestive system (<10%) = 1μg/L x 3 L x 0,1 = **0,3 μg**

Daily mercury retention from food:

R_{food} = sum of products of average daily consumption of food of vegetal and animal origin of an adult and limit concentration of mercury in that food x absorption inorganic, namely organic linked mercury (the relative amount of the inorganic related mercury in food of 80% is assumed).

In Table 4, there is a method of calculation of the allowable daily amount of mercury with food. Average daily

Apsorpcija anorganski vezane žive iz probavnog sistema je 10%, a organski vezane 95%.

$$R_{hrana} = 52 \times 0,1 \times 0,8(\text{anorg. Hg}) + 52 \times 0,95 \times 0,3(\text{org. Hg}) = 18,98 \mu\text{g}$$

Kako su R_{vazduh} , R_{voda} i R_{hrana} izračunate vrijednosti zadržane količine žive u osoba izloženih graničnim koncentracijama žive u tim medijima, može se zaključiti da bi to trebale biti maksimalno podnošljive količine dnevno zadržane žive u organizmu, tj. one ispod kojih ne treba očekivati negativne učinke. Razlike između tih izračunatih vrijednosti (17,6 μg dan; 0,3 μg dan; 18,98 μg dan) nisu male, pa je teško prihvatiti da su i 0,4 μg d i 18,98 μg d, vrijednosti koje su u odnosu 1:64, prihvatljive maksimalno podnošljive zadržane količine žive u organizmu, tj. one iznad kojih se mogu očekivati negativni učinci. Ipak, ako se te vrijednosti prihvate, dobiva se da je ukupno dnevno podnošljivo zadržavanje žive u organizmu iz svih medija $17,6 + 0,3 + 18,98 = 36,9 \mu\text{g}$ dan. Privremeni podnošljivi sedmični unos (Provisional Tolerable Weekly Intake) utvrđen od FAO/WHO Joint Committee on Food Additives (JECFA) samo za aditive hrani je 5 $\mu\text{g}/\text{kg}$ tjelesne težine; 5 $\mu\text{g}/\text{kg}/\text{sedmično} = 320 \mu\text{g}/64 \text{ kg}/\text{sedmično} = 46 \mu\text{g}/64 \text{ kg}$ dan.

Tabela 4. Dopustivi dnevni unos žive u organizam hranom

| Namirnica / Food | Prosječna dnevna potrošnja (g dan) / Average daily consumption (g day) | Dopuštena koncentracija ($\mu\text{g}/\text{g}$) / Tolerable concentration ($\mu\text{g}/\text{g}$) | Dopušteni dnevni unos (μg dan) / Tolerable daily intake (μg day) |
|---|--|---|--|
| Meso / Meat | 125 | 0,03 | 3,75 |
| Masti i ulja / Fat and oil | 31 | 0,3 | 9,3 |
| Riba / Fish | 23 | 0,5 | 11,5 |
| Jaja / Eggs | 19 | 0,05 | 0,95 |
| Mlijeko i proizvodi / Milk and products | 360 | 0,02 | 7,2 |
| Žitarice, brašno, riža / Cereals, flour, rice | 323 | 0,04 | 12,9 |
| Povrće, voće / Vegetables, fruit | 325 | 0,02 | 6,5 |
| Ukupno / Total | | | 52,1 |

U tabeli 5. prikazane su konkretne situacije iz dva područja u kojima je dokazana izloženost živi iznad graničnih koncentracija. U tim je područjima potrošnja ribe s relativno visokim koncentracijama žive značajna (prosječno 350 g ribe sedmično); u drugim namirnicama sadržaj žive je zanemarljiv.

consumption is taken from the assessment of the International Commission for radiological protection based on the analyses in seven geographic areas. The absorption of the inorganically linked mercury from digestive system is 10%, while it is 95% when it comes to the organically linked one.

$$R_{food} = 52 \times 0,1 \times 0,8(\text{anorg. Hg}) + 52 \times 0,95 \times 0,3(\text{org. Hg}) = 18,98 \mu\text{g}$$

Since the R_{air} , R_{water} and R_{food} are the calculated values of the retained amount of mercury with persons exposed to the limit concentrations of mercury in those media, it can be concluded that it should be at maximum tolerable amounts of daily retained mercury in the body, i.e. the ones below which the negative effects should not be expected. Differences between those calculated values ((17,6 μg day; 0,3 μg day; 18,98 μg day) are not small, so it is difficult to accept that both 0,4 μg d and 18,98 μg d are the values that are in the ratio 1:64 acceptable at maximum tolerable retained mercury amounts in the body, i.e. the ones above which the negative impacts may be expected. However, if those values are accepted, it is understood that totally daily tolerable retention of mercury in the body from all media $17,6 + 0,3 + 18,98 = 36,9 \mu\text{g}$ day. Provisional Tolerable Weekly Intake determined by FAO/WHO Joint Committee on Food Additives (JECFA) only for the food additives is 5 $\mu\text{g}/\text{kg}$ of the weight; 5 $\mu\text{g}/\text{kg}/\text{weekly} = 320 \mu\text{g}/64 \text{ kg}/\text{weekly} = 46 \mu\text{g}/64 \text{ kg}$ day.

Table 4. Tolerable daily intake of mercury in the body with food

In Table 5, there are concrete situations in two areas in which the exposure to mercury above the limit concentrations is proven. In those areas, the fish consumption with relatively high concentration of mercury is significant (350 g of fish weekly); in other kinds of food, the content of mercury is negligible.

Tabela 5. Koncentracija i zadržavanje žive u dva područja**Table 5. Concentration and retention of mercury in two areas**

| Područje / Area | Vazduh / Air | Voda / Water | Riba (50g d) / Fish (50g d) |
|---|--|-----------------------------------|-----------------------------|
| Koncentracije / Concentration | | | |
| A | 1,5 µg/m ³ | 100 µg/L | 0,5 µg/g |
| B | 0,01 µg/m ³ | 10 µg/L | 0,4 µg/g |
| Dnevno zadržavanje u organizmu / Daily retention in the body | | | |
| A | 20m ³ x1,5µg/m ³ x0,8 =24µg | 2L x 100µg/Lx0,1 =20µg | 50gx0,5µg/gx0,95 =24µg |
| B | <0,16µg | =2µg | =19µg |
| Ukupno dnevno zadržavanje (µg d) / Total daily retention (µg d) | | | |
| Područje A / Area A: 24 +20+24=68 | | Područje B / Area B: 0,16+2+19=21 | |

Prekomjerno dnevno zadržavanje u području A: ukupno dnevno zadržavanje-maksimalno podnošljivo dnevno zadržavanje = 68-32=36 µg dan. Uz zabranu upotrebe pitke vode koja sadrži živu smanjilo bi se prekomjerno zadržavanje na 36-20=16 µg dan. Uz zadržavanje iste prosječne potrošnje ribe, trebalo bi iz prehrane isključiti ribu sadržaja žive iznad 0,15 µg/g (smanjenje: 50 g ribe x 0,35 x 0,95 = 16,6 µg d) i pored normativne monomedijske granične koncentracije žive za ribu od 0,5 µg/g. Druga bi mogućnost bila smanjiti potrošnju ribe na jednu trećinu sadašnje (potrebno smanjenje potrošnje: 16 : /0,5 x 0,95/ = 33,7 g, dakle na 50-34=16 g d, odnosno 112 g sedmično). Na taj način bi se smanjilo ukupno dnevno zadržavanje žive u organizmu na prihvatljivo, pa ne bi bilo neophodno postići tehnički komplikovano i skupo smanjenje koncentracije žive u vazduhu ispod normativne granice od 1 µg/m³.

Ukupno dnevno zadržavanje u području B mnogo je manje od maksimalno podnošljivog (21 µg d < 32 µg d), pa je stanje u medijima životne sredine prihvatljivo za sportiste. Ipak, uz primjenu monomedijskog normativnog pristupa trebalo bi, značajno smanjiti koncentraciju žive u pitkoj vodi koja je 10 puta viša od normativno dopuštene (10 µg/L : 1 µg/L).

U multimedijском pristupu donošenju normativa dopustilo bi se prekoračenje granične vrijednosti u jednom mediju, ako su koncentracije u drugim značajno niže od graničnih, a sve uz uslov da nije prekoračeno maksimalno podnošljivo ukupno dnevno zadržavanje zagađujuće materije u organizmu sportiste iz svih medija životne sredine.

Na primjeru fenola prikazujemo kako se mogu izvesti i opravdano primjenjivati različite granične koncentracije za istu materiju u istom mediju uz primjenu multimedijского pristupa donošenju normativa. U tabeli 6. prikazane su pretpostavljene koncentracije fenola u tri medija životne sredine u dva područja.

Excessive daily retention in the area A: total daily retention – maximum tolerable daily retention = 68-32=36 µg day. Prohibition of use of the drinking water which contains mercury would reduce the excessive retention to 36-20=16 µg day. With retention of the same average consumption of fish, the fish of the mercury content of more than 0,15 µg/g (reduction: 50 g of fish x 0,35 x 0,95 = 16,6 µg d) also apart from the standard monomedia limit concentration of mercury for fish of 0,5 µg/g, should be excluded from human consumption. Another possibility would be to reduce the consumption of fish to one third of the current (the required reduction of consumption: 16:/0,5 x 0,95/= 33,7 g, so to 50-34=16 g d namely 112 g weekly). In that way, total daily retention of mercury in the body is acceptable, so it would not be necessary to achieve technically complicated and expensive reduction of the mercury concentration in air below the standard limit of 1 µg/m³.

Total daily retention in the Area B is much less than maximum tolerable (21 µg d < 32 µg d), so the situation in the environmental media is acceptable for sportsmen. However, the application of monomedia standard approach should significantly decrease the mercury concentration in the drinking water which is 10 times more than the one allowed by the standard (10 µg/L : 1 µg/L).

In the multimedia approach to determination of standard, the excess of the limit values (10 µg/L : 1 µg/L) in one media would be allowed, provided that concentrations in other ones are considerably lower than the limit ones, everything provided that the maximum tolerable total daily retention of the polluting matter in the sportsman body from all environmental media is not exceeded.

Applying the phenol example, we show how to conduct and apply in a justified way different limit concentrations for the same matter in the same media applying multimedial approach to development of standard. In Table 6, there are assumed concentrations of phenols in three environmental media in two areas:

Tabela 6. Koncentracije fenola u dva područja

| Područje / Area | Atmosfera / Atmosphere ($\mu\text{g}/\text{m}^3$) | Voda / Water ($\mu\text{g}/\text{L}$) | Dimljeno meso / Smoked meat ($\mu\text{g}/\text{g}$) |
|-----------------|---|---|--|
| A | 3 ^a | 1 ^b | 2 ^c |
| B | 104 ^d | 10 ^e | 18 ^f |

a - područja bez specifičnih izvora zagađenja

b - najčešće koncentracije u pitkoj vodi

c - najniža koncentracija mjerena u dimljenoj šunki i kobasima

d - područje s izvorima emisije fenola

e - zagađena voda

f - najviša koncentracija mjerena u dimljenoj šunki i kobasima

Table 6. Concentration of phenol in two areas

a - area without specific sources of pollution

b - the most frequent concentration in drinking water

c - the lowest concentration measured in the smoked ham and sausages

d - area with sources of the phenol emissions

e - polluted water

f - the maximum concentration measured in the smoked ham and sausages

Tabela 7. Izračunati dnevni unosi fenola iz pojedinih medija u organizam odrasle osobe, koja se bavi sportskim aktivnostima, izraženi u $\mu\text{g}/\text{kg}$ tjelesne težine

Table 7. Calculated daily intakes of phenol from some media in the body of an adult, going in for sport activities, expressed in $\mu\text{g}/\text{kg}$ of body weight

| Medij / Media | Područje / Area A | Područje / Area B |
|---|---|--|
| Atmosfera / Atmosphere | $\frac{3\mu\text{g}/\text{m}^3 \times 22\text{m}^3}{64\text{kg}} = 1,03\mu\text{g}/\text{kgd}$ | $\frac{104\mu\text{g}/\text{m}^3 \times 22\text{m}^3}{64\text{kg}} = 35,8\mu\text{g}/\text{kg}$ |
| Voda / Water | $\frac{1\mu\text{g}/\text{L} \times 2\text{L}/\text{d}}{64\text{kg}} = 0,03\mu\text{g}/\text{kg}$ | $\frac{10\mu\text{g}/\text{L} \times 2\text{L}/\text{d}}{64\text{kg}} = 0,3\mu\text{g}/\text{kgd}$ |
| Dimljeno meso (200 g sed.) / Smoked meat (200 g sed.) | $\frac{1/7 \times 200 \times 2\mu\text{g}/\text{g}}{64\text{kg}} = 0,89\mu\text{g}/\text{kgd}$ | $\frac{1/7 \times 200 \times 2\mu\text{g}/\text{g}}{64\text{kg}} = 8,0\mu\text{g}/\text{kgd}$ |

U tabeli 7. prikazani su izračunati prosječni dnevni unosi fenola u organizam odrasle osobe koja se bavi sportskim aktivnostima. Kako je apsorpcija fenola u organizmu iz svih medija visoka, brza i podjednaka, pretpostavljena je praktično potpuna apsorpcija.

Ukupni dnevni unos fenola u organizam u području A je $1,03 + 0,03 + 0,89 = 1,95 \mu\text{g}/\text{kg d}$, a relativni dnevni unos iz pojedinih medija je $1,03/1,95 \times 100 = 52,8\%$ iz vazduha, $0,03/1,95 \times 100 = 1,5\%$ iz vode, te $0,89/1,95 \times 100 = 45,6\%$ iz hrane..

Ukupni dnevni unos fenola u području B je $35,8 + 0,3 + 8,0 = 44,1 \mu\text{g}/\text{kg d}$, a relativni dnevni unos je $35,8/44,1 \times 100 = 81,2\%$ iz vazduha, $0,34/44,1 \times 100 = 0,7\%$ iz vode, te $8,0/44,1 \times 100 = 18,1\%$ iz hrane.

Maksimalno podnošljivi ukupni dnevni unos fenola za odraslu osobu koja se bavi sportskim aktivnostima (ocijenjen toksikološki na osnovu ispitivanja na štakoru pa ekstrapoliran na čovjeka) je $60 \mu\text{g}/\text{kg d}$. Maksimalno podnošljivi dnevni unos iz pojedinog medija može se izvesti dodjeljivanjem toj vrijednosti iste proporcije koja je dobivena izračunavanjem relativnog unosa na osnovu analize prosječne izloženosti dotične populacije, kako je prikazano u tabeli 8.

In Table 7, there are the calculated average daily intakes of phenol in the body of an adult going in for sport activities. Since the phenol absorption in the body from all media is high, quick and roughly equal, the full absorption was practically assumed.

Total daily intake of phenol in the body in the Area A is $1,03 + 0,03 + 0,89 = 1,95 \mu\text{g}/\text{kg d}$, while a relative daily intake from some media is $1,03/1,95 \times 100 = 52,8\%$ from air, $0,03/1,95 \times 100 = 1,5\%$ from water, and $0,89/1,95 \times 100 = 45,6\%$ from food.

Total daily intake of phenol in the Area B is $35,8 + 0,3 + 8,0 = 44,1 \mu\text{g}/\text{kg d}$, while a relative daily intake is $35,8/44,1 \times 100 = 81,2\%$ from air, $0,34/44,1 \times 100 = 0,7\%$ from water, and $8,0/44,1 \times 100 = 18,1\%$ from food.

Maximum tolerable total daily intake of phenol for an adult going in for sport activities (toxicologically assessed based on the tests applied with rats and extrapolated to the man) is $60 \mu\text{g}/\text{kg d}$. Maximum tolerable daily intake from some particular medium may be obtained allocating the same proportions to that value which was obtained by calculating the relative intake based on the analysis of the average exposure of the respective population, as presented in Table 8.

Tabela 8. *Maksimalno podnošljivi dnevni unosi u područjima A i B izraženi na kilogram tjelesne težine osoba koje se bave sportskim aktivnostima*

| Medij / Media | Područje / Area A | Područje / Area B |
|------------------------|--|---|
| Atmosfera / Atmosphere | $60 \mu\text{g/kg d} \times 0,528 = 31,7 \mu\text{g/kg d}$ | $60 \mu\text{g/kg d} \times 0,812 = 48,72 \mu\text{g/kg d}$ |
| Voda / Water | $60 \mu\text{g/kg d} \times 0,015 = 0,9 \mu\text{g/kg d}$ | $60 \mu\text{g/kg d} \times 0,007 = 0,42 \mu\text{g/kg d}$ |
| Hrana / Food | $60 \mu\text{g/kg d} \times 0,456 = 27,4 \mu\text{g/kg d}$ | $60 \mu\text{g/kg d} \times 0,181 = 10,86 \mu\text{g/kg d}$ |

Table 8. *Maximum tolerable daily intakes in the Areas A and B expressed per kg of the body weight of persons going in for sport activities*

Iz tih vrijednosti podnošljivih relativnih unosa mogu se izračunati granične koncentracije fenola za pojedine medije.

ZAKLJUČAK

Granična koncentracija određene zagađujuće materije u pojedinim medijima životne sredine ne mora biti jednaka u svim geografskim područjima, kao što je to danas kao posljedica monomedijskog pristupa donošenju tih vrijednosti. Takva granična koncentracija u jednom mediju može biti viša, ako su koncentracije istovremeno u drugom ili ostalim medijima niže. To je važno ne samo pri ocjenjivanju ugroženosti sportista nego posebno pri eliminisanju ugroženosti. Može se izabrati sniženje koncentracije zagađenja u mediju u kojem je to tehnički i ekonomski najlakše učiniti, ili bilo koju kombinaciju postupaka, uz uslov da ukupni unos u organizam sportiste ne pređe unos toksikološki ocijenjen kao podnošljiv.

U multimedijском pristupu donošenju normativa dopustilo bi se prekoračenje granične vrijednosti u jednom mediju, ako su koncentracije u drugim značajno niže od graničnih. Na primjeru fenola pokazano je kako se mogu izvesti i opravdano primijeniti različite granične koncentracije za istu materiju u istom mediju uz primjenu multimedijского pristupa donošenju normativa.

Izjava autora

Autori pridonijeli jednako.

Konflikt interesa

Mi izjavljujemo da nemamo konflikt interesa.

Limit concentrations of phenol for some media may be calculated from those values of the tolerable relative intakes.

CONCLUSION

Limit concentrations of some polluting matter in some environmental media should not be equal in all geographical areas as it is today, being the consequence of the monomedia approach to making those values. Such limit concentration in one media may be higher, provided that concurrently the concentrations in another or other media are lower. It is important not only while estimating the vulnerability of the sportsmen but especially while eliminating the vulnerability. Reduction of the pollution concentration in the media may be chosen or any combination of procedures provided that the total intake in the body of the sportsman does not exceed the intake toxicologically assessed as tolerable.

In the multimedia approach to development of the standard, the excess of the limit value in one media would be allowed if the concentrations in other are considerably lower than the limit ones. It was shown applying the phenol example how to conduct and apply in a justified way different limit concentrations for the same matter in the same media applying multimedia approach to development of the standard.

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The authors have contributed equally.

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Pregledni rad

Review Paper

RAZLIKE U MORFOLOŠKIM KARAKTERISTIKAMA ATLETIČARKI SKAKAČICA FINALISTA OLIMPIJSKIH IGARA U PEKINGU

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Sažetak: Antropološki prostor je vrlo značajan i primaran u selekciji, usmjeravanju i postizanju rezultata u sportu. To se naročito ispoljava u vrhunskom sportu gdje se postižu izuzetni rezultati. Zavisno od sporta, sportske discipline zavisi i učešće i uticaj antropološkog prostora, odnosno njegovih segmenata na ukupan rezultat. Kada se opisuje i definiše određena populacija sportista, njihov morfološki prostor, najčešće se kao parametri analiziraju tjelesna visina, tjelesna masa, body mass index, a vrlo često i starosna dob ispitanika. Ovi parametri su vrlo pouzdani i daju realnu sliku o morfološkom prostoru ispitivane populacije. U radu su analizirane razlike u segmentima morfološkog prostora atletičarki skakačica, finalistkinja Olimpijskih igara u Pekingu. Uzorak je obuhvatio 32 takmičarke u četiri discipline (skok u dalj, skok u vis, troskok, skok motkom). Analizirane su razlike u tjelesnoj visini, masi tijela, BMI i starosnoj dobi. Za obradu podataka primjenjen je T-test za male nezavisne uzorke koji je potvrdio postojanje statistički značajnih razlika u tjelesnoj visini atletičarki u disciplinama: skok u dalj - skok u vis ($T=-2.906$, $p<0.05$), skok u vis - troskok ($T=3,448$; $p<0.01$), skok u vis - skok motkom ($T=3,469$; $p<0.01$). Razlike su potvrđene i u vrijednostima BMI u disciplinama: skok u vis-skok u dalj ($T=3,496$; $p<0.01$) i skok u vis-troskok ($T=-3,136$; $p<0.01$)

Ključne riječi: morfološke karakteristike, atletičarke, Olimpijske igre, skakačke discipline.

Uvod

Atletika kao grana sporta sa velikim brojem disciplina u muškoj i ženskoj konkurenciji zauzima vrlo važno mjesto u hijerarhiji sportova, a vrlo često je nazivaju kraljicom sportova, zbog istorijskog nastanka i razvoja, velikog broja disciplina (hodanja, trčanja, skokovi, bacanja) i uticaja atletskih kretanja u razvoju jed-

DIFFERENCES IN MORPHOLOGICAL CHARACTERISTICS OF FEMALE ATHLETICS JUMPERS FINALISTS OF THE BEIJING OLYMPICS

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Abstract: Anthropological space is very important and primary in the selection, targeting and achieving results in sport. This is particularly apparent in professional sport where remarkable results are achieved. Depending on the sport and sport discipline, the participation and influence of human space, or its segments depend on the total score. When describing and defining specific populations of athletes, their morphological status, the most common parameters that are taken are body height, body weight, body mass index, and very often the age of the respondents. These parameters are very reliable and give a true picture of the morphological area of the studied population. This paper analyzes the differences in the segments of morphologic space of female jumpers, the finalists of the Beijing Olympics. The sample included 32 competitors in four jumping disciplines (Long jump, High jump, Triple jump, Pole vault). Differences in Body height, Body weight, BMI and age were analysed. For data processing T-test has been applied for small independent samples that confirmed the presence of statistically significant differences of Body height female competitors between disciplines: Long jump- High jump ($T=-2,906$; $p<0.05$), High jump-Triple jump ($T=3,448$; $p<0.01$) and High jump-Pole vault ($T=3,469$; $p<0.01$). The differences were confirmed in BMI values in the disciplines: High jump-Long jump ($T=3,496$; $p<0.01$) and High jump-Triple jump ($T=-3,136$; $p<0.01$).

Key words: morphological characteristics, female jumpers, jumping disciplines, differences, Olympic game.

INTRODUCTION

Athletics as a branch of sport with a large number of sports disciplines in the men and women competition occupies a very important place in the hierarchy of sports and is often called the queen of sports, because of the historical emergence and development, of a large number of disciplines (walking, running, jumping, throwing), and the impact

nog normalnog psihosomatskog i motoričkog razvoja organizma čovjeka u smislu ovladavanja, usavršavanja, nadogradnje i provjere motoričkih i funkcionalnih sposobnosti čovjeka (Pavlović, 2010). Ono što je interesantno i vrlo česta tema mnogih razgovora, kad se govori o atletici uopšte, jesu njene discipline i rezultati koji se u njima postižu, odnosno koje atletičari ostvaruju kao svoje lične rekorde. Tu se nameću brojna pitanja? Obično se govori o njihovim trenažnim tehnologijama, vrsti i sastavu opreme, neke novine u njihovim modelima, načinu ishrane i njenom uticaju na organizam atletičara (unos UH, masti, proteina), trenažnom procesu (trajanje mikro, mezo, makrociklusa, obimu i intenzitetu rada), korišćenju (ne) dozvoljenih stimulativnih sredstava kojima u poslednje vrijeme pribjegava veći broj atletičara u cilju postizanja što boljeg rezultata, iako svjesni posljedica koje slijede, diskvalifikacija, zabrane takmičenja na kraćem i dužem vremenskom periodu, a vrlo često negativnim posljedicama na trajno zdravlje sportiste. Pored ovih pitanja na koje imamo nekada potpune a nekada nepotpune odgovore, česta su i ona koja se tiču morfološkog i motoričkog prostora atletičara. Oba prostora su vrlo važna u rezultatskoj uspješnosti i plasmanu i obično se analiziraju u korelaciji, zavisno od discipline i njenog načina izvođenja. Ipak, najbolji rezultati se postižu ukoliko postoji visoka korespondencija između ovih prostora, a što zahtijeva određena disciplina. Pored motoričkih sposobnosti koje imaju vrlo važnu ulogu, ništa manje ne zaostaju i morfološke dimenzije na bazi kojih se pravi selekcija i usmjeravanje mladih atletičara u određenu disciplinu u kojoj se očekuje postizanje najboljih rezultata (Milanović, i sar. 1986; Radić i Simeonov, 2012). Naime, poznato je da skakačke discipline karakteriše povećana longitudinalnost i transverzalnost skeleta, manja tjelesna masa i na bazi kojih se pravi jedan model skakača (Pavlović, 2013). Generalno uzevši, skakači su visokog rasta i relativno manje tjelesne mase, dugih nogu, dugih i tankih mišića. Po konstituciji je vodeći leptosomni tip sa učešćem atletskog tipa (Kobrinskij, Juškevič, Konikova, 2005). Skakači u dalj i u troskoku se po izgledu i konstituciji približavaju sprinterima (Radić i Simeonov, 2012). Jedna od osnovnih karakteristika koja je opšta za sve skakače u vis, jeste njihova tjelesna visina. Osam finalista Olimpijskih igara u Pekingu imali su visinu tijela od 181-199 cm kod muških i 175-193 kod žena (Pavlović, 2012). Skakači u vis imaju duge noge i srazmjerno tome kraći trup. Mogućnost procjene definitivne tjelesne visine skakača dječaka i djevojčica početnika može se suditi po njihovoj dužini šaka i stopala. Ukoliko su

of athletic movement in a normal psychosomatic development and motor development of a human in sense of mastery, training, upgrading and testing of motor and functional abilities of man (Pavlovic, 2010). What is interesting and a very common topic of many conversations, when it comes to athletics in general, is its disciplines and the results achieved in them, that is which the athletes achieve as their personal records. This imposes a number of questions. Usually we talk about their training technologies, type and composition of the equipment, what is the equipment made of, some new things in their models, diet and its impact on athletes' body (carbohydrates, fats, proteins), the training process (duration of the micro, meso, macrocycle, scope and intensity of work); using (not) allowed stimulants which lately use a number of athletes in order to achieve better results, although aware of the consequences that follow, a disqualification, prohibition of competition in the short and long periods of time, and often negative consequences on the permanent health of athletes. In addition to these questions at which we have complete and sometimes incomplete answers, often are those concerning the morphological and motor space of athletes. Both spaces are very important in the result success and placement and usually are analyzed in correlation, depending on the discipline and its method of execution. However, best results are achieved if there is a high correspondence between these spaces, which requires a certain discipline. In addition to motor skills, which have a very important role, no less lag have morphological dimensions on the basis of which selection and guidance of young athletes in a particular discipline is made, in which is expected the achievement of the best results (Milanović, et al. 1986; Radić & Simeonov, 2012). Namely, it is known that jumping disciplines are characterized by increased longitudinality and transversality of the skeleton, lower body weight and on the basis of which is made one model of jumper (Pavlović, 2013). Generally, the jumpers (male and female) are tall and relatively of less weight, long legs, long and thin muscles. According to the constitution the leading is leptosom type with the participation of thletics (Kobrinskij, Juškevič & Konikova, 2005). Long jumper and triple jumper are by their appearance and constitution closer to the sprinters (Radić & Simeonov, 2012). One of the main characteristic that is general for all the jumpers in the air is their body height. Eight finalist jumpers in the Olympic Games Beijing have a height of 181-199cm for males and 175-193 for females (Pavlović, 2012). Jumpers in the air have long legs and comparatively short torso. About the possibility of increasing the body height of boys and girls jumping beginners can be judged by their long hands and feet. If the child's hands and feet are long, that is the assumption that in the future will come to the leveling of body proportions (Đurašković, 1997).

šake i stopala djeteta dugi, to je pretpostavka da će u budućnosti doći do izravnavanja proporcije cijelog tijela (Đurašković, 1997). Kao pokazatelj motoričkog stanja skakača javlja se potencijal brzinske snage, koji se ispoljava kod brzog i maksimalno snažnog odskoka, kada pritisak na tlo prevazilazi težinu sportiste 6-7 puta. Za ovo je potrebna specifična snaga, ne samo nogu već i svih mišićnih grupa. U svim daljinskim i visinskim skokovima, od faze odskoka pa do doskoka, dolazi do izražaja sinhronizovano djelovanje mišićnih kinetičkih lanaca, koji se prostire od stopala do mišića ruku i ramenog pojasa. Za izvođenje složenih radnji, kako prilikom ulaska u odskok, tako i prilikom samog skoka, potreban je visok nivo koordinacije pokreta i dobro stanje vestibularnog aparata. Potreba većih amplituda prilikom zamajnih pokreta kod varijanti skokova zahtijeva da skakači postignu visoku pokretljivost i mišićnu elastičnost (Bowerman et al. 1998).

U okviru skakačkih disciplina uočavaju se određene razlike ali i sličnosti u pogledu morfološkog statusa atletičara skakača u dalj, troskoku, skoku u vis, skoku motkom. Postojeće razlike i sličnosti između ovih disciplina su uslovljene fizičkim stanjem takmičara, tehnikom izvođenja svake od disciplina, uticajem endogenih faktora itd. U istraživanju (Pavlović, Radić, Simeonov, i sar. 2013) analizirane su razlike u antropološkom prostoru skakača finalista Olimpijskih igara u Pekingu. Primjenjen je T-test za male nezavisne uzorke koji je potvrdio postojanje statistički značajnih razlika samo u tjelesnoj visini između skakača u dalj i skakača troskoka ($T=-2,747$; $p<0,05$) i skakača u dalj i skakača u vis ($T=-2,280$; $p<0,05$).

Upravo iz tih razloga je interesantno definisati cilj ovog istraživanja a koji tretira problem morfološkog statusa atletičarki skakačica finalistkinja na Olimpijskim igrama u Pekingu 2008. godine gdje bi se na bazi njihovih parametara mogla dobiti realna slika o morfološkom statusu i starosnoj strukturi ženskih finalista.

METOD

Istraživanjem je obuhvaćen uzorak od 32 vrhunskih atletičarki u skakačkim disciplinama (skok u dalj, skok u vis, troskok, skok motkom) koje su nastupile u finalu Olimpijskih igara u Pekingu 2008. godine. Varijable koje su uzete u analizu su one koje definišu: visinu tijela (Body Height-cm), masu tijela (Body Weight-kg), Body Mass Index (BMI-kg/m²) i godine života (Age).

Da bi se dobili relevantni rezultati na bazi kojih se mogu dobiti odgovori, primjenjeni su osnovni statistički parametri, a u pogledu utvrđivanja razlika izvršena je analiza primjenom T-testa za male nezavisne uzorke.

As an indicator of physical condition of jumper, there is the potential of speed power, which is expressed at speed and a maximum strong rebound when the pressure on the soil exceeds the weight of athlete 6-7 times. This requires a specific power, not only of legs but of all muscle groups.

In all the remote and high-altitude jumps from the stage of take-off until drop jumps, comes into play synchronized actions of muscular kinetic chains, which extends from the foot to the muscles of arms and shoulders. To perform complex actions, both when entering the bounce, and during the jump, a high level of coordination of movements is needed and a good state of the vestibular apparatus. The need of larger amplitude in swing movements at variants of jumps requires that jumpers achieve high mobility and muscle elasticity (Bowerman et al. 1998). Within jumping disciplines some differences can be observed but also similarities in terms of the morphological status of athlete jumping long jump, triple jump, high jump, pole vault. The existing differences and similarities between these disciplines are conditioned by the physical condition of athletes, technique of performing each of the disciplines, the influence of endogenous factors and so on.

In the research (Pavlović, Radić, Simeonov, et al. 2013), the differences in the segments of human space of male jumpers, the finalists of the Beijing Olympics were analyzed. For data processing T-test has been applied for small independent samples that confirmed the presence of statistically significant differences of body height between long jump and triple jump ($T=-2,747$; $p<0.05$) and long jump and high jump ($T=-2,280$; $p<0.05$). For these reasons, it is interesting to define the objective of this research which treats the problem of the morphological status of female finalists jumpers at the Olympic Games in Beijing in 2008, where would be possible, on the basis of their parameters, to get a realistic picture of the morphological status and age structure of the finalists female jumpers.

METHODS

The study encompassed a sample of 32 top women athletes in jumping disciplines (long jump, high jump, triple jump, pole vault) that occurred in the finals of the Olympic Games in Beijing in 2008. Variables that were taken in the analysis are those that define the morphological space and the age structure of competitors: *Body Height* (Height-cm), *Body mass* (Weight-kg), *Body mass index* (BMI- kg/m²) and *Age*. In order to get relevant results on the basis of which one can get answers, basic statistical parameters were applied, and in terms of identifying the differences the analysis has been performed by using T-test for independent small samples.

REZULTATI I DISKUSIJA

U tabeli 1. prezentovani su parametri atletičarki za svaku disciplinu pojedinačno. U tabelama 2-7 nalaze se osnovni statistički parametri morfološkog statusa istraživog uzorka atletičarki-skakačica kao i rezultati T-testa.

Tabela 1. *Morfološki parametri finalista skakačica*

| SKOK U DALJ / / LONG JUMP | Visina / Height (cm) | Masa / Weight (kg) | Godine života / Age | BMI (kg/m ²) | TROSKOK / TRIPLE JUMP | Visina / Height (cm) | Masa / Weight (kg) | Godine života / Age | BMI (kg/m ²) |
|------------------------------|----------------------------|--------------------------|---------------------------|-----------------------------|-----------------------------|----------------------------|--------------------------|---------------------------|-----------------------------|
| M H. Maggi (BRA) | 173 | 61 | 32 | 20,40 | F. Etone (CAM) | 172 | 63 | 32 | 21,35 |
| T. Lebedeva (RUS) | 170 | 61 | 32 | 21,10 | T. Lebedeva (RUS) | 170 | 61 | 32 | 21,10 |
| B. Okagbare (NIG) | 180 | 60 | 20 | 18,51 | H. Devetzi (GRE) | 170 | 59 | 33 | 20,41 |
| C. Hammond (JAM) | 175 | 62 | 25 | 20,26 | O. Rypakova (KZH) | 182 | 61 | 24 | 18,42 |
| B. Reese (USA) | 170 | 61 | 22 | 21,10 | Y. Savigne (CUB) | 165 | 55 | 24 | 20,22 |
| O. Udmurtova (RUS) | 172 | 58 | 26 | 19,66 | M. Šestak (SLO) | 173 | 59 | 29 | 19,73 |
| J. Johnson (GBR) | 185 | 70 | 28 | 20,46 | V. Gurova (RUS) | 178 | 62 | 26 | 19,62 |
| G. Upshaw (USA) | 173 | 59 | 33 | 19,73 | A. Pyatikh (RUS) | 175 | 60 | 27 | 19,60 |
| SKOK U VIS / / HIGH JUMP | Visina / Height (cm) | Masa / Weight (kg) | Godine života / Age | BMI (kg/m ²) | SKOK MOTKOM / POLE VAULT | Visina / Height (cm) | Masa / Weight (kg) | Godine života / Age | BMI (kg/m ²) |
| T. Hellebaut (BEL) | 182 | 62 | 21 | 18,73 | Y. Isinbayeva (RUS) | 174 | 65 | 26 | 21,52 |
| B. Vlašić (CRO) | 193 | 70 | 25 | 18,81 | J. Stuczinski (USA) | 183 | 63 | 26 | 18,86 |
| A. Chicherova (RUS) | 180 | 57 | 26 | 17,59 | S. Feofanova (RUS) | 164 | 52 | 28 | 19,40 |
| Y. Slesarenko (RUS) | 179 | 54 | 26 | 16,87 | Y. Golubchikova (RUS) | 175 | 54 | 25 | 17,64 |
| V. Palamar (UKR) | 187 | 66 | 31 | 18,91 | M. Pyrek (POL) | 168 | 52 | 28 | 18,43 |
| C. Howard (USA) | 175 | 60 | 24 | 19,60 | C. Hingst (GER) | 170 | 60 | 28 | 20,76 |
| A. Friedrich (GER) | 179 | 61 | 24 | 19,06 | S. Spiegelburg (GER) | 173 | 64 | 22 | 21,40 |
| R. Beitia (GER) | 192 | 71 | 29 | 19,29 | A. S. Bennett (USA) | 175 | 61 | 28 | 19,93 |

RESULTS AND DISCUSSION

Table 1 presents the parameters of female athletes in each discipline individually. Tables 2-7 are the basic statistical parameters of the morphological status of the study sample of female athletes-jumpers and the results of T-test.

Table 1. *Morphological parameters female jumper finalists*

Tabela 2. Razlike između skoka u dalj i troskoka**Table 2.** Differences Long jump- Triple jump

| | | Mean | SD | T | p |
|-----------------|--------------------|--------|------|------|------|
| Visina / Height | Skok u dalj / Long | 174,75 | 5,23 | ,620 | ,545 |
| | Troskok / Triple | 173,13 | 5,25 | | |
| Masa / Weight | Skok u dalj / Long | 61,50 | 3,66 | ,963 | ,352 |
| | Troskok / Triple | 60 | 2,45 | | |
| Godine / Age | Skok u dalj / Long | 27,25 | 4,86 | -523 | ,609 |
| | Troskok / Triple | 28,38 | 3,66 | | |
| BMI / BMI | Skok u dalj / Long | 20,15 | ,85 | ,215 | ,833 |
| | Troskok / Triple | 20,06 | ,93 | | |

Legenda: Mean-srednja vrijednost, SD-standardna devijacija; T-t test; p-nivo značajnosti

Legend: Mean-standard deviation, SD-standard deviation; T-value-test p-level of significance * Sig. ($p < 0.05$)

Tabela 3. Razlike između skoka u dalj i skoka u vis**Table 3.** Differences Long jump - High jump

| | | Mean | SD | T | p |
|-----------------|--------------------|--------|------|--------|--------|
| Visina / Height | Skok u dalj / Long | 174,75 | 5,23 | -2,906 | ,012* |
| | Skok u vis / High | 183,38 | 6,57 | | |
| Masa / Weight | Skok u dalj / Long | 61,50 | 3,66 | -,453 | ,658 |
| | Skok u vis / High | 62,63 | 6,00 | | |
| Godine / Age | Skok u dalj / Long | 27,25 | 4,86 | -,735 | ,474 |
| | Skok u vis / High | 25,75 | 3,11 | | |
| BMI / BMI | Skok u dalj / Long | 20,15 | ,85 | 3,496 | ,004** |
| | Skok u vis / High | 18,61 | ,91 | | |

Legenda: Mean-srednja vrijednost, SD-standardna devijacija; T-t test; p-nivo značajnosti *Sig. ($p < 0.05$); **Sig. ($p < 0.01$)

Legend: Mean-standard deviation, SD-standard deviation; T-value-test p-level of significance *Sig. ($p < 0.05$); **Sig. ($p < 0.01$)

Tabela 4. Razlike između skoka u dalj i skoka motkom**Table 4.** Differences Long jump - Pole vault

| | | Mean | SD | T | p |
|-----------------|--------------------|--------|------|-------|------|
| Visina / Height | Skok u dalj / Long | 174,75 | 5,23 | ,735 | ,475 |
| | Skok motkom / Pole | 172,75 | 5,65 | | |
| Masa / Weight | Skok u dalj / Long | 61,50 | 3,66 | 1,136 | ,275 |
| | Skok motkom / Pole | 58,88 | 5,41 | | |
| Godine / Age | Skok u dalj / Long | 27,25 | 4,86 | ,466 | ,648 |
| | Skok motkom / Pole | 26,38 | 2,13 | | |
| BMI / BMI | Skok u dalj / Long | 20,15 | ,85 | ,702 | ,494 |
| | Skok motkom / Pole | 19,74 | 1,42 | | |

Legenda: Mean-srednja vrijednost, SD-standardna devijacija; t-t test; p-nivo značajnosti *Sig. ($p < 0.05$); **Sig. ($p < 0.01$)

Legend: Mean-standard deviation, SD-standard deviation; T-value-test p-level of significance * Sig. ($p < 0.05$); **Sig. ($p < 0.01$)

Tabela 5. Razlike između skoka u vis i troskoka**Table 5. Differences High jump-Triple jump**

| | | Mean | SD | T | p |
|-----------------|-------------------|--------|------|--------|--------|
| Visina / Height | Skok u vis / High | 183,38 | 6,57 | -3,448 | ,004** |
| | Troskok / Triple | 173,13 | 5,25 | | |
| Masa / Weight | Skok u vis / High | 62,63 | 6,00 | -1,146 | ,271 |
| | Troskok / Triple | 60 | 2,45 | | |
| Godine / Age | Skok u vis / High | 25,75 | 3,11 | -1,546 | ,144 |
| | Troskok / Triple | 28,38 | 3,66 | | |
| BMI / BMI | Skok u vis / High | 18,61 | ,91 | -3,136 | ,007** |
| | Troskok / Triple | 20,06 | ,93 | | |

Legenda: Mean-srednja vrijednost, SD-standardna devijacija; T-t test; p-nivo značajnosti **Sig. (p<0.01)

Legend: Mean-standard deviation, SD-standard deviation; T-value-test p-level of significance ** Sig. (p <0.01)

Tabela 6. Razlike između skoka u vis i skoka motkom**Table 6. Differences High jump - Pole vault**

| | | Mean | SD | T | p |
|-----------------|--------------------|--------|------|--------|--------|
| Visina / Height | Skok u vis / High | 183,38 | 6,57 | -3,469 | ,004** |
| | Skok motkom / Pole | 172,75 | 5,65 | | |
| Masa / Weight | Skok u vis / High | 62,63 | 6,00 | -1,313 | ,210 |
| | Skok motkom / Pole | 58,88 | 5,41 | | |
| Godine / Age | Skok u vis / High | 25,75 | 3,11 | -,469 | ,646 |
| | Skok motkom / Pole | 26,38 | 2,13 | | |
| BMI / BMI | Skok u vis / High | 18,61 | ,91 | -1,905 | ,077 |
| | Skok motkom / Pole | 19,74 | 1,42 | | |

Legenda: Mean-srednja vrijednost, SD-standardna devijacija; T-t test; p-nivo značajnosti **Sig. (p<0.01)

Legend: Mean-standard deviation, SD-standard deviation; T-value-test p-level of significance **Sig. (p <0.01)

Tabela 7. Razlike između troskoka i skoka motkom**Table 7. Differences Triple jump - Pole vault**

| | | Mean | SD | T | p |
|-----------------|--------------------|--------|------|--------|------|
| Visina / Height | Troskok / Triple | 173,13 | 5,25 | ,138 | ,893 |
| | Skok motkom / Pole | 172,75 | 5,65 | | |
| Masa / Weight | Troskok / Triple | 60 | 2,45 | ,536 | ,601 |
| | Skok motkom / Pole | 58,88 | 5,41 | | |
| Godine / Age | Troskok / Triple | 28,38 | 3,66 | -1,335 | ,203 |
| | Skok motkom / Pole | 26,38 | 2,13 | | |
| BMI / BMI | Troskok / Triple | 20,06 | ,93 | ,524 | ,609 |
| | Skok motkom / Pole | 19,74 | 1,42 | | |

Legenda: Mean-srednja vrijednost, SD-standardna devijacija; T-t test; p-nivo značajnosti

Legend: Mean-standard deviation, SD-standard deviation; T-value-test p-level of significance * Sig. (p <0.05)

Slika 1. Srednje vrijednosti antropometrijskih parametara

Pregledom i analizom razlika aritmetičkih sredina definisanih segmenata morfološkog prostora atletičarki uočavaju se razlike u visini tijela i to u disciplinama skok u dalj - skok u vis ($t=-2,906$; $p<0.01$) gdje su skakačice u vis u prosjeku bile višije od skakačica u dalj (mean=183,38cm). Razlike su zabilježene između skakačica u vis i troskoku ($T=3,448$; $p<0.01$), u korist skakačica u vis koje su imale veću tjelesnu visinu (mean=183,38cm) i disciplini skok u vis - skok motkom ($T=3,469$; $p<0.01$).

Statističke razlike su zabilježene i u vrijednostima BMI u disciplinama skok u dalj-skok u vis ($T=3,496$; $p<0.01$) i skok u vis-troskok ($T=-3,136$; $p<0.01$). U drugim parametrima su također evidentirane razlike ali one nisu ostvarile statističku značajnost ili su bile na samoj granici statističke značajnosti. Ova analiza je pokazala sličnosti u morfološkom statusu skakača ženskih finalista OI U Pekingu. Slične rezultate istraživanja dobili su Pavlović, Radić, Simeonov i sar. (2013) kod muških finalista u Pekingu. Analizirajući muške finaliste također su zabilježene razlike u visini tijela u disciplinama: skok u dalj - troskok ($T=-2,747$; $p<0.05$) i skok u dalj-skok u vis ($T=-2,280$; $p<0.05$).

Na slici 1. predstavljene su srednje vrijednosti **visine tijela (Body Height)** u skakačkim disciplinama. Uvidom u numeričke parametre može se zaključiti da sužene u disciplini skok u vis imale najveću visinu tijela (Mean=183,38cm) u rasponu od 175-193cm. Odmah iza njih su takmičarke u skoku u dalj (oko 175cm) i troskoku (Mean=173,12), a kao najmanje tjelesne visine su bile atletičarke u skoku motkom (Mean=172,25). Iz ovih numeričkih pokazatelja može se zaključiti da su ova tri rezultata (skok u dalj, troskok, skok motkom) kvantitativno dosta homogena u pogledu longitudinalnosti skeleta (razlika je oko 2,5 cm). Kod skakača u vis, generalno, je potrebna tjelesna visina, koju prati povećana dužina ekstremiteta, visina težišta tijela od podloge, sam način izvođenja tehnike, gdje pored brzine, fleksibilnosti, eksplozivne snage važna dužina trkačkih, odnosno skakačkih koraka. Atletičarke u skoku motkom su u prosjeku bile najniže sa prosječnom visinom (Mean=172,25cm).

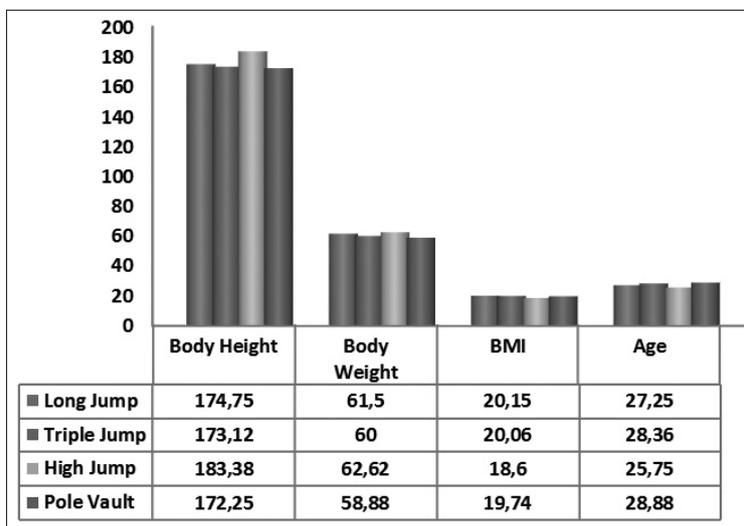


Figure 1. Mean values of anthropometric parameters

By review and analysis of mean differences of defined segments of the morphological space in female athletes we can see differences in body height, in these disciplines Long Jump - High jump ($T=-2.906$, $p<0.01$) where

the high jumpers were on average taller than long jumpers (Mean = 183,38cm). Differences were observed between the high jumpers and triple jump ($T= 3.448$; $p<0.01$), in favor of the female high jumpers that had greater body height (Mean = 183.38 cm) and discipline high jump - pole vault ($T= 3.469$; $p<0.01$).

Statistical differences were also observed in BMI values in the disciplines Long Jump- High jump ($T=3.496$; $p<0.01$) and High Jump-Triple jump ($T=-3.136$; $p<0.01$). In other parameters, differences were also recorded but these differences did not achieve statistical significance or were on the verge of achieving it. This analysis showed similarities in the morphological status of women jumper finalists of the Olympic Games in Beijing. Similar research results obtained Pavlovic, Radic, Simeonov, et al. (2013) in male finalist in Beijing. Analyzing the men's finalists differences were also observed in the body height in the following disciplines: Long jump-Triple jump ($T=-2.747$; $p<0.05$) and Long Jump-High jump ($T=-2.280$; $p<0.01$).

Figure 1 represents the mean values of body height (Body Height) in jumping disciplines. After examining the numerical parameters it can be concluded that the women in the discipline high jump, had the greatest height of the body (Mean=183.38 cm) in the range of 175-193cm. Right behind them are competitors in the long jump (about 175cm) and triple jump (Mean=173.12), and a minimum body height were athletes in the pole vault (Mean=172.25cm). From these numerical results, it could be concluded that these three results (Long Jump, Triple Jump, Pole Vault) are quantitatively quite homogeneous in terms of longitudinally skeleton (the difference is about 2.5cm). In high jumpers, generally, the more necessary is body height, accompanied by increased limb length, the height of the center of gravity of the body from the ground, a way of performing a technique, where in addition to the speed, flexibility, explosive strength, length

Ova visina atletičarki u skoku motkom može se obrazložiti na sledeći način, a tiče se tehnike izvođenja i motoričkih sposobnosti. Visina tijela kao parametar uspešnosti skoka motkom nije toliko važan segment, jer skok motkom predstavlja jedno kombinovano kretanje gdje skakač upotrebljava motku kao rekvizit. Ostvareni rezultat najčešće zavisi od sinhronizacije njegovih, prvenstveno motoričkih sposobnosti, brzine, eksplozivne snage, koordinacije, fleksibilnosti, ravnoteže, kao i sposobnosti takmičara da kinetičku energiju (brzina zaleta) pretvori u potencijalnu (pokreti nakon uboda motke u kutiju).

Manju prosječnu tjelesnu visinu su zabilježile takmičarke u disciplini skok u dalj (Mean=174,75cm) i troskoku (Mean=173,12cm). Naime, poznato je da visina tijela ne igra važnu ulogu kod ovih skakačkih disciplina, mada je i tu poželjno da su skakači viši, naročito kod troskoka. Rezultat, pored tehničke izvedbe uglavnom zavisi od motoričkih komponenti, u prvom redu od brzine i eksplozivne snage (u toku zaleta i momentu odraza) a zatim od koordinacije i fleksibilnosti (nakon odraza do doskoka) što opet zavisi od toga o kojoj se varijanti radi (uvinuće ili koračna). Poznato je da je skok u dalj ciklično-aciklično kretanje gdje rezultat zavisi od brzine zaleta i početne brzine prilikom odraza i taj odnos je 2:1 u korist brzine, gdje vrhunski skakači u toku zaleta postižu brzinu preko 10m/s, a početna brzina u momentu odraza preko 8,5m/s (Čoh, 2002; Pavlović, 2010). Kod troskoka je taj odnos 3:1, gdje se sa opadanjem brzine kretanja, povećava ugao odraza između odraza, koraka i skoka (14°-21°).

Analizom srednjih vrijednosti **mase tijela (Body Weight)** finalistkinja u skakačkim disciplinama (slika 1), evidentne su najveće vrijednosti numeričkih parametara, takođe kod skakačica u vis (Mean=62,62kg) u rasponu od 54-71kg. Na drugoj poziciji su skoro ujednačene, takmičarke u skoku u dalj (Mean=61,50kg) i troskoku (Mean=60kg) u rasponu od minimalnih 59kg pa do maksimalnih 71kg. Najmanju tjelesnu masu u prosjeku su imale atletičarke u skoku motkom (Mean=58,88kg) u rasponu od 52kg do 65kg.

Ovakav poredak atletičarki, po tjelesnoj masi je možda i neočekivan (naročito u skoku u vis), jer povećana tjelesna masa, sa jednog aspekta predstavlja remeteći faktor u rezultatskoj uspešnosti, naročito kod visinskih skokova, gdje postoji veliki uticaj sile teže na tijelo, u momentu odraza, koja nastoji da prizemlji skakača na tlo. Posmatrajući sa drugog aspekta, odraz kod svih skokova se izvodi sa jedne noge i vrlo je teško izdržati veliku tjelesnu masu na jednoj nozi (4-6 puta veća od mase skakača), pa je manja tjelesna masa poželjna. Kod skoka s

of race is important, that is the jumping movements. Female pole-vaulters were on average the lowest average height (Mean=172.25 cm). This height in the pole vault female athletes can be explained as follows, and refers to the techniques involved, and motor skills. Body height as a parameter of success of pole vault is not so important segment because pole vault is one combined movement where jumper uses the pole as a prop. The achieved result usually depends on the synchronization of its primarily motor skills, speed, explosive strength, coordination, flexibility, balance, and the ability of competitors to kinetic energy (speed running) turn into a potential (movements after sticking the pole in a box).

Lower average height was recorded among the competitors in the long jump discipline (Mean=174.75cm) and triple jump (Mean=173.12 cm). Namely, it is known that the height of the body does not play an important role in this jumping discipline, although it is preferred that the jumpers are taller, particularly for triple jump. The result, in addition to technical performance mainly depends on the motor components, primarily from the speed and explosive power (during acceleration and moment of reflection) and then from the coordination and flexibility (after reflection to landing) which in turn depends on which variant it is about (twist or stepping). It is known that the high jump is cyclic-acyclic movement where the result depends on the speed of run up and initial velocity during the take off and the ratio is 2:1 in favor of speed, where the top jumpers in the course of running speed achieved over 10m/s, and the initial speed in the moment of take off was over 8.5 m/s (Čoh, 2002, Pavlovic, 2010). In triple jump the ratio 3:1 is; where the decrease in speed increases the angle of take off between take off, step and jump (14° - 21°).

By the analysis of the mean body weight (Body Weight) in female finalists in the jumping disciplines (Figure 1), the highest values of numerical parameters are evident, also in female high jumpers (Mean=62.62kg) in the range of 54-71kg. The second position is almost uniform, competitors in the long jump (Mean=61.50kg) and triple jump (Mean=60kg) ranging from a minimum 59kg to a maximum of 71kg. The lowest body weight on average had athletes in the pole vault (Mean=58.88 kg) in the range of 52kg-65kg.

This order of women athletes, by the body weight is perhaps surprising (especially in the high jump), because increased body mass, with one aspect, is a disturbing factor in the result success, especially in high jumps, where we have a large influence of gravity on the body at the moment of take off, which seeks to ground jumper to the ground. Looking from another perspective, take off in all jumps is per-

motkom veća masa tijela ima negativan uticaj zbog ograničene čvrstoće kao i elastičnosti motke i njenog boljeg dejstva u momentu opružanja, kada tijelo skakača treba da podigne na određenu visinu, gdje se mnogo bolje dejstvo ispoljava kod skakača sa manjom tjelesnom masom, djelujući kao luk i strijela, odnosno u fazi skupljanja koja prethodi fazi opružanja, gdje tijelo skakača podsjeća na strijelu, a savijena motka na luk (Jovović, 2006; Pavlović, 2010).

Kada su u pitanju numeričke srednje vrijednosti *Body Mass Index-a (BMI)* atletičarki finalista, na prvom mjestu su skakačice u dalj, sa najvećom prosječnom vrijednosti BMI (Mean=20,15) u rasponu vrijednosti od 18,51-21,10. Na osnovu ove vrijednosti može se zaključiti da su takmičarke skoka u dalj imale manju tjelesnu visinu u odnosu na masu tijela i po konstituciji odgovaraju atletiku, a njihov rezultat je uglavnom vezan sa motoričke sposobnosti. Takmičarke u troskoku su u prosjeku imale indeksne vrijednosti (BMI=20,06), raspona od 18,42–21,35. Proizilazi zaključak da su i one imale manju visinu tijela u odnosu na tjelesnu masu (kao kod skoka u dalj). Dobijeni su podaci da su takmičarke u disciplini skok u vis zabilježile najmanje srednje indeksne vrijednosti (BMI=18,60), u rasponu od minimalnih 16,87 do maksimalnih 19,69 (tabela 1). To je i očekivano što je i karakteristika skakača u vis, da imaju veću tjelesnu visinu u odnosu na masu tijela. Takođe takmičarke u skoku motkom (pole vault) su imale manji BMI u odnosu na takmičarke u disciplinama skok u dalj i troskok, ali veći BMI u odnosu na takmičarke u skoku u vis (Mean=19,74) u rasponu rezultata od 17,64-21,52. Takođe i ova disciplina zahtjeva manje vrijednosti BMI takmičara.

Što se tiče *starosne strukture (GOD)* učesnika (slika 1) takmičarke u skoku u vis su bile najmlađe učesnice finala sa prosjekom od 25,75 decimalnih godina, u rasponu od 21-31 godine. Na drugom mjestu su takmičarke skoka u dalj (Mean=27,25; Range=20-33). Atletičarke u skoku s motkom i troskoku su bile skoro ujednačene u starosnoj dobi (Triple jump=28,36). Kao najstarije učesnice finala skakačkih disciplina su bile takmičarke u skoku s motkom, 28,88 decimalnih godina. Može se napomenuti, da je u svim disciplinama bilo i većih numeričkih pokazatelja u starosnoj dobi, ali su uglavnom preovladale takmičarke sa manjim brojem godina što se odrazilo na ukupnu prosječnu starosnu dob.

Po visini i muški i ženski skakači se takođe razlikuju, zavisno o kojoj se disciplini radi. Kao "najviši" su skakači u vis, zatim troskokaši. Obzirom da visina tijela nije toliko značajan faktor za skok u dalj i skok motkom, proizilazi da su ovi skakači (muški i ženski) niži rastom u

formed with one foot and it is very difficult to sustain a large body weight on one leg (4-6 times that of the jumper), and so lower body weight is preferred. In the pole vault higher body mass has a negative impact due to the limited strength and elasticity of the pole and its better effect at the time of stretching, when the body of jumper should be raised to a certain height, where much better effect is expressed in a jumper with less body mass, acting like a bow and arrow, the body of the jumper with respect to the bent pole, respecting at the stage of collecting that precedes stage of stretching, where the body jumpers reminiscent of arrow and a bent rod on bow (Jovovic, 2006; Pavlovic, 2010).

As for the numerical median values of Body Mass Index's (BMI) in women athlete finalists at the first place are long jumpers, with the highest average value of BMI (Mean=20.15) ranging in value from 18.51 to 21,10. Based on these values it can be concluded that the contestants in long jump had lower body height in relation to the mass of the body and by the constitution correspond to athletics, and their result is mainly associated with motor skills. Contestants in the triple jump had an average BMI values (Mean=20.06), ranging from 18.42 to 21.35. This leads to the conclusion that they had smaller height of the body relative to body weight (as in the long jump). It is interesting data that the competitors in the discipline high jump recorded the lowest median BMI values (Mean=18.60), ranging from a minimum of 16.87 to a maximum of 19.69 (table 1). It is expected, which is the characteristic of the high jumpers, to have a greater height of the body relative to the weight of the body. Also competitors in the pole vault had a lower BMI compared to competitors in events long jump and triple jump, but higher BMI compared to competitors in the high jump (Mean=19.74) in the range of scores from 17.64 to 21.52. Also, this discipline requires lower values of BMI competitors.

Regarding the age structure (age) of participants (Figure 1), competitors in the high jump were the youngest participants in the finals with an average of 25.75 decimal years, ranging from 21-31 years. In second place were the contestants in long jump (Mean = 27.25, range = 20-33). Athletes in the pole vault and triple jump were almost uniform in age (Triple jump = 28,36). As the oldest participants in the finals of jumping disciplines were competitors in the pole vault, 28.88 decimal years. It may be noted that in all disciplines numerical indicators of age were larger, but generally prevailed competitors with fewer years which resulted in an overall average age.

Jumpers also differ by height, depending which discipline is in question. As the tallest are the high jumpers, then triple jumpers. Since the height of the body is not a

odnosu na discipline skok u vis i troskok. Kada je u pitanju tjelesna masa, može se zaključiti da je ona remeteći faktor kod svih skakačkih disciplina. Ona je nešto veća kod skakača u dalj u odnosu na skakače u vis, troskokaše i skakače motkom. Veće vrijednosti mase tijela imaju negativan uticaj u fazi leta zbog većeg djelovanja sile gravitacije na skakača, a takođe zbog većeg ispoljavanja mišićne sile kod momenta odraza (Kobriniskij, Juškevič, Konikova, 2005). Naime, odskok se vrši sa jedne noge gdje skakači vrše aktivni pritisak na podlogu 4-6 puta veći od svoje tjelesne mase, što iznosi od 350kg-500kg (Čoh, 2002) i vrlo je teško izdržati taj pritisak na jednoj nozi (traje vrlo kratko 0,12-0,16ms), što se naročito ispoljava kod troskoka i to prvog koraka nakon odraza. Kod troskoka karlica i kičmeni stub trpe veliko opterećenje i ukoliko bi tjelesna masa bila povećana, uspješnost tehničkog izvođenja bi bila manja, a mogućnost povređivanja bila veća, iako se radi o vrhunskoj fizičkoj pripremi tih takmičara. Skok u dalj kao disciplina je specifična, jer je brzina dominantna u rezultatskoj uspješnosti, gdje je odnos brzine i snage odraza 2:1 i vrlo često kažemo da je dobar sprinter i dobar skakač i obratno. Brzina zaleta koju postižu skakači iznosi od 10,30m/s do 11,50m/s, a početna brzina u momentu odskoka je nešto manja, oko 9,50m/s (Čoh, 2002., Pavlović, 2010; Stanković i Raković, 2010). Skakači u dalj su uglavnom jake reljefne muskulature sa snažnim ekstremitetima, širokih ramena i dugih mišića potkoljenica, koji djeluju kao poluge brzine.

Ovakve činjenice se mogu argumentovati i rezultatima ovoga rada na finalistima OI-a 2008.godine. Pored ove konstatacije poznato je da atletski skokovi pripadaju grupi balističkih gibanja u kojima se u prostor katapultira tijelo skakača posredstvom vlastitih mišićnih naprezanja ili uz pomoć rekvizita (skok motkom) u cilju ostvarenja što veće dužine skoka. Skokovi su inicirani eksplozivnom aktivacijom mišića agonista, nakon čega slijedi period njihove relaksacije, a završavaju se periodom deceleracije, uslijed djelovanja mišića antagonista ili pasivnog istezanja vezivnog tkiva. Većina istraživača koji su se bavili istraživanjem u prostoru morfoloških karakteristika se slažu, da skakači imaju u odnosu na ostale atletičare veću količinu aktivne tjelesne mase, te da su po Šeldonovoj klasifikaciji najbliži atletiku (skok u dalj i skok motkom) odnosno leptosomu (skok u vis, troskok), (Milanović i sar. 1986; Bowerman i sar., 1998; Tončev, 2001; Čoh, 2002; Pavlović, 2010).

Masa tijela atletičarki skakačica, učesnica finalnog takmičenja na OI u Pekingu je u prosjeku iznosila od 58,88-62,62kg, sa izolovanim slučajevima gdje je težina

significant factor in the long jump and pole vault, it appears that these jumpers (male and female) are of lower height compared to the previous two events. Regarding the body weight, it can be concluded that it is a disturbing factor of all jumping disciplines. It is slightly higher in long jumpers compared to the high jumpers, triple jumpers and pole-vaulters. Higher values of body weight have a negative impact on the phase of flight due to the larger action of gravity on a jumper, and also because of the higher manifestation of muscle force at the moment of take off (Kobriniskij, Juškevič, & Konikova, 2005). Namely, the bounce is carried out with the one leg, where the jumpers do active pressure on surface, 4-6 times greater than their body weight, which amounts from 350 kg-500 kg (Čoh, 2002) and it is very difficult to withstand the pressure on one leg (takes a very short 0.12 to 0.16 ms), which is specifically expressed in the triple jump and the first steps after takeoff. In triple jump, the pelvis and spinal column suffer a great load, and if the body weight was increased the success of technical performance would be lower and the risk of injury would be higher, although it is about the top physical preparation of the athletes. The long jump as the discipline is specific, because the speed is dominant in result performance, where the ratio of the speed and strength of take off is 2:1 and often we say it is a good sprinter and a good jumper and vice versa. The speed of run up achieved by jumpers is from 10.30 m/s to 11.50 m/s, and the initial speed at the moment of rebound is slightly smaller, about 9.50 m/s (Čoh, 2002nd, Pavlovic, 2010; Stankovic and Rakovic, 2010). The long jumpers are generally of strong relief musculature with powerful limbs, broad shoulders and long lower legs, which act as levers of speed. These facts can be argued by the results of this study on the finalists Olympics in 2008. In addition to these, it is known that athletic jumps belong to a group of ballistic motion in which body of jumper is catapulted in the space through his own muscle strain or with the help of props (pole vault) in order to achieve the greater length of the jump. The jumps are initiated by explosive activation of agonists muscles, followed by their relaxation period, and they end by period of deceleration, due to the action of the antagonist muscles or passive stretching of the connective tissue. Most researchers who were engaged in research in the area of morphological characteristics agree that the jumpers in comparison to other athletes have greater amount of active body mass, and that by the Sheldon classification they are closest to the athletics (long jump and pole) that is to leptosom (high jump, triple jump), (Milanovic et al. 1986, Bowerman et al., 1998, Tonchev, 2001; Čoh 2001; Kobriniskij, Juškevič & Konikova, 2005; Pavlovic, 2010).

pojedinih takmičarki i preko 70kg, dok prosječna visina deset najboljih skakačica u vis iznosi od 178-188cm. Prosječna visina učesnica finala OI-a u Pekingu iznosila je od 172,25cm (Pole vault) pa do 183, 38cm (High jump). Zbirno, za sve četiri discipline prosjek visine je iznosio (Body Height=175,87cm), a prosjek tjelesne mase (Body Weight=60,75kg). Skakačice u vis imale su najveću tjelesnu masu ali i najmanji prosjek BMI, upravo iz razloga jer su imale veću visinu u odnosu na masu tijela kod većeg broja takmičarki i u potpunosti odgovaraju leptosomu. Za razliku od skakača u dalj koji odgovaraju atletiku i koje su imale najveći BMI (Mean=20,15). Generalno, vrijednosti BMI su takođe vrlo homogene i niske, kretale su se u granicama od 18,60 (High jump) do 20,15 (Long jump). Srednja vrijednost BMI je iznosila 19,63. Niske vrijednosti BMI kod skakača su očekivane obzirom na tehniku izvođenja discipline i značaj mase tijela u izvođenju koja se karakteriše kao negativan faktor.

Vrlo je važno napomenuti da kategorizacija na osnovu BMI u ovim atletskim disciplinama je vrlo pouzdana jer se radi od kategoriji sportista kojima tjelesna masa nije balast (već masa mišića i kostiju) pomaže u izvođenju motoričkog zadatka. Ako bi kategorisali ženske finalistice OI-a u Pekingu po BMI onda bi sve takmičarke bile u kategoriji ispod normalne težine, BMI= 21-25 (Wilmore et al.1986). Obzirom da se radi o utreniranim vrhunskim sportistima, onda ova skalarna procjena se ne može uzeti za korektnu.

Prosječna starost takmičarki je bila 27,56 decimalnih godina, što je više nego kod muških finalista (Pavlović, Radić, Simeonov, i sar. 2013) gdje su najmlađe bile takmičarke u skoku u vis (Mean=25,75) a najstarije u disciplini skok s motkom (Mean=28,88 god).

Na osnovu dobijenih rezultata ovog istraživanja utvrđene su razlike između finalista skakačica, ali samo su statistički značajne u parametrima tjelesne visine i BMI. Evidentno je da su morfološke karakteristike relevantne u skakačkim disciplinama, naročito skoku u vis. Međutim, pored morfoloških karakteristika izuzetan doprinos u rezultatskoj uspješnosti daljinskih i visinskih skokova imaju motoričke sposobnosti koje nisu analizirane u ovom istraživanju. Ono što je relevantno, a potvrđeno u praksi je to, da rezultat u skakačkim disciplinama pored morfoloških dimenzija (visina, masa, BMI) je definisan biomehaničkim parametrima: brzinom zaleta, odraznim impulsom i zamahom ekstremiteta (Stefanović, 1992; Jarić, 1997; Tončev, 2001; Jovović, 2006, Pavlović, 2010; Radić i Simeonov, 2012) koji takođe imaju značajan udio u izvođenju tehnike kretanja.

Body mass of women athlete jumpers, participating at finals at the Olympic Games in Beijing averaged from 58.88 to 62.62 kg, with isolated cases where the weight of individual competitors was over 70kg, while the average height of ten best female high jumpers was between 178 - 188cm. The average height of the female participants in Olympic final in Beijing ranged from 172.25 cm (pole vault) to 183, 38cm (high jump). Collectively, for all four disciplines the average height was (Body Height=175.87 cm), and the average body mass was (body weight=60.75 kg). Women high jumpers had the highest body mass and the lowest average BMI, precisely because they had greater height in relation to body mass in a large number of competitors and entirely match to leptosome, unlike the long jumpers who match the athletics and who had the highest BMI (Mean=20.15). Generally, BMI values are also very low and homogeneous, they were in the range of 18.60 (high jump) to 20.15 (Long jump). The mean BMI was 19.63. Low values of BMI in jumpers are expected because of the technique of performing the discipline and the importance of body weight in the performance which is characterized as a negative factor.

It is important to note that categorization on the basis of BMI in these athletic disciplines is very reliable because it is the category of athletes to which the body weight is not a burden (but muscles mass and bones) and assists in the performance of motor task. If you would categorize women's Olympic finalist in Beijing by BMI then all competitors would be in the category of below normal weight, BMI 21-25 (Wilmore et al.1986). Since it is about trained elite athletes, then this scalar evaluation cannot be taken as correct.

The average age of the competitors was 27.56 decimal years, which is longer than that of the male finalists (Pavlovic, Radic, Simeonov, et al. 2013) where the youngest competitors were in the high jump (Mean = 25.75) and the oldest in discipline pole vault (Mean = 28.88 years).

Based on received results of this research, there were differences between the finalists of female high jumper, but only statistically significant in the parameters of body height and BMI. It is evident that the morphological characteristics are relevant in the jumping disciplines, especially the high jump. However, in addition to morphological characteristics, an outstanding contribution to the success of scores in remote and dive jumps have motor skills that are not analyzed in this study. What is relevant, and confirmed in practice, is that result in the jumping disciplines in addition to morphological dimensions (height, weight, BMI) is defined by biomechanical parameters: speed running start, take-off impulse and momentum ex-

ZAKLJUČAK

Na osnovu dobijenih i prezentovanih rezultata istraživanja morfološkog prostora finalistkinja u skakačkim disciplinama na Olimpijskim igrama u Pekingu 2008. godine može se zaključiti da su takmičarke u ove četiri discipline dosta sličnog morfološkog statusa. Razlike koje su zabilježene potvrđuju ranije konstatacije o mogućim sličnostima i razlikama u skakačkim disciplinama. Od ukupnog broja finalista skakačica (ukupno 32) evidentirane su razlike u pogledu tjelesne visine, mase tijela, Body Mass Index (BMI) i godina starosti (Age).

Međutim, u pogledu statističke značajnosti, to se potvrdilo u tjelesnoj visini na oba nivoa ($p < 0.05$; $p < 0.01$). Atletičarke u disciplinama skok u dalj i skok u vis se statistički značajno razlikuju u vrijednostima visine tijela ($T = -2,906$; $p < 0,012$). Razlike su takođe utvrđene između skoka u vis i troskoka ($T = 3,448$; $p < 0,004$), kao i skoka u vis i skoka motkom ($T = 3,136$; $p < 0,007$).

Razlike u vrijednostima BMI atletičarki su utvrđene u disciplinama skok u dalj - skok u vis ($t = 3,496$; $p < 0.004$) i skok u vis-troskok ($T = -3,136$; $p < 0.007$).

Od svih finalista atletičarke u skoku u vis su imale najveću visinu tijela (Mean=183,38cm). Skoro identične vrijednosti se mogu pripisati skakačicama u dalj (Mean=174,75cm) i skakačicama u troskoku (Mean=173,12cm). Kao najniže rastom su bile atletičarke u skoku motkom (Mean=172,25cm). Analizom tjelesne mase finalista može se zaključiti da su i najveću masu imale atletičarke skoka u vis (Mean=62,62). Drugu poziciju zauzimaju atletičarke u skoku udalj (Mean=61,50kg) i u troskoku (Mean=60kg), a kao 'najlakše' su skakačice s motkom, sa prosječnom masom od 58,88kg. Uvidom u vrijednosti BMI finalistkinja, može se zaključiti da su najveće vrijednosti kod skakačica u dalj (BMI=20,15). Na drugoj poziciji su atletičarke u troskoku (BMI=20,06), zatim skakačice motkom (BMI=19,74). Najmanje vrijednosti BMI su zabilježile atletičarke u skoku u vis (BMI=18,60).

Analizom starosne strukture ženskih finalista može se zaključiti da su takmičarke u skoku motkom bile najstarije učesnice finala sa prosjekom od 28,88 godina, a blizu njih i atletičarke u troskoku sa 28,36 godina. Na trećem mjestu po starosnoj dobi su bile atletičarke u skoku u dalj (27,25 godina), dok su kao najmlađe učesnice u skakačkim disciplinama bile atletičarke skoka u vis sa prosjekom 25,75 godina.

Ovakav poredak je u suprotnosti od muških finalista (Pavlović, Radić, Simeonov, i sar. 2013), jer su kod njih troskokaši ti koji su nešto više tjelesne mase od očekivane. Sve skakačke discipline u svojoj tehnici imaju

tremities (Stefanovic, 1992; Jaric, 1997; Toncev, 2001; Jovovic, 2006, Pavlovic, 2010; Radic & Simeonov, 2012) which also have a significant proportion of the technique of movement.

CONCLUSION

Based on obtained and presented results of research of morphological space in finalists in the female jumping events at the Olympic Games in Peking 2008, it can be concluded that the female contestants in these four disciplines are of quite similar anthropological status. The differences that were observed confirm previous findings about the possible similarities and differences in the jumping disciplines. Of the total number of finalist jumpers (total of 32) there were recorded differences in body height (body height), body mass (body weight), Body Mass Index (BMI) and age (Age). However, in terms of statistical significance, that is confirmed in the body height at both levels ($p < 0.05$, $p < 0.01$). Female athletes in the disciplines long jump and high jump, statistically significantly differ in the values of Body Height ($T = -2.906$, $p < 0.012$). Differences were also observed between the high jump and triple jump ($T = 3.448$, $p < 0.004$), as well as the high jump and pole vault ($T = 3.136$, $p < 0.007$). Differences in BMI were determined in women athletes in the disciplines long jump – high jump ($T = 3.496$, $p < 0.004$) and high jump-triple jump ($T = -3.136$, $p < 0.007$). Of all the finalists, women athletes in the high jump had the highest body height (Mean = 183.38 cm). Almost identical values can be attributed to the long jumpers (Mean = 174.75 cm), the triple jumpers (Mean = 173.12 cm). As lowest by height were female pole-vaulter (Mean = 172.25 cm).

By the analysis of body mass of finalists it can be concluded that the maximum mass had high jump female athletes (Mean = 62.62). The second position is that of competitors in the long jump (Mean = 61.50 kg) and triple jump (Mean = 60kg), and with lowest weight are women pole vaulters, with an average weight of 58.88 kg. After examining the values of BMI finalists, it can be concluded that the greatest values are in long jumpers (BMI= 20.15). In the second position are the triple jumpers (BMI= 20.06), followed by pole-vaulters (BMI= 19.74). The minimum values of BMI were recorded in female athletes in high jump (BMI= 18.60). By the analysis of the age structure of women's finalists it can be concluded that the competitors in the pole vault were the oldest participants in the finals with an average of 28.88 years, and close to them are competitors in triple jump with 28.36 years. In third place by age were competitors in the long jump (27.25 years), while the youngest participants in the jumping events were high

učešće brzine i eksplozivne snage koje sa starošću opadaju (Nićin, 2000), pa ovdje imamo upravo i takav primjer starosne strukture učesnika i njihovih godina u momentu Olimpijskih igara.

jump athletes with an average of 25.75 years. This order is contrary to the male finalists (Pavlovic, Radic, Simeonov, et al. 2013), because triple jumpers are those who are of little greater body mass than expected. All the jumping disciplines in their technique have the participation of speed and explosive strength that decreases with age, so here we have just such an example of the age structure of participants and their age at the time of the Olympics.

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Short notice

UČESTALOST I EFIKASNOST UBACIVANJA LOPTE U IGRU SA STRANE U SAVREMENOM FUDBALU

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Apstrakt: Istraživanjem je pokušano da se rasvetli jedan deo strukture takmičarske aktivnosti fudbala i efikasnost jednog od "prekida igre". Predmet rada predstavlja učestalost i efikasnost ubacivanja lopte u igru sa strane. Cilj rada je da se utvrdi postojanje eventualnih razlika u učestalosti i efikasnosti ubacivanja lopte u igru sa strane na utakmicama finalista i polu-finalista Svetskog fudbalskog prvenstva 2010. godine. Od 255 izvedenih ubacivanja lopte u igru sa strane na tzv."protivničkoj" polovini terena postignut je jedan gol u nastavku akcije posle izvedenog ubacivanja lopte u igru sa strane. Primenom Kruskall Wallis testa između četiri prvoplasirane reprezentacije na Svetskom fudbalskom prvenstvu 2010. godine dobijene su statistički značajne razlike kod izvedenih ubacivanja lopte u igru sa strane u šesnaesterac protivnika ($p=0.003$) i kod upućenog šuta prema голу protivnika, a lopta ode pored ili iznad gola ili je golman uhvati ili odbije ($p=0.009$).

Ključne reči: fudbal, prekidi igre, ubacivanje lopte u igru sa strane, Svetsko fudbalsko prvenstvo 2010. godine.

Uvod

Jedan od ofanzivnih prekida igre u fudbalu su i ubacivanja lopte u igru sa strane. U tu grupu spadaju još i ubacivanja lopte u igru iz ugla, slobodni udarci, kazneni udarci koji se još nazivaju i penali, ubacivanja lopte u igru od strane golmana kada lopta pređe gol aut liniju, a njom je poslednji igrao igrač protivničke ekipe i izvođenje početnog udarca na početku utakmice, početkom drugog poluvremena i posle svakog primljenog gola.

Igrači koji imaju dobru tehniku i koji mogu snažno baciti loptu iz "auta" ostvaruju veliku taktičku prednost. Izvedeći aut u blizini protivničkog gola, igrači mogu postići iste efekte kao da je lopta centrirana nogom pred protivnički gol (Aleksić, 1990).

Jedan od poslednjih primera efikasno izvedenog ubacivanja lopte u igru sa strane dogodio se na utakmici između F.K."Čelzi" i F.K."Pari Sen Žermen" u četvrt-

FREQUENCY AND EFFICIENCY OF PUTTING THE BALL INTO PLAY FROM THE SIDE IN MODERN FOOTBALL

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Abstract: The study attempts to elucidate a part of the structure of competitive football activities and efficiency of the one "interruption of the game." The paper topic is the frequency and effectiveness of putting the ball into play from the side. The paper aims to establish the existence of possible differences in the frequency and efficiency of putting the ball into play from the side at the matches of finalists and semi-finalists of the World Championship in 2010. Out of 255 times the ball was put into play from the side in the so-called "opponent's" half of the field, one goal was scored in the continuation of action after the ball was put into play from the side. By using the Kruskal Wallis test between the four best ranked national teams of the World Championship in 2010, there were statistically significant differences in putting the ball into play from the side as a result of ball throw into the opponent's box ($p = 0.003$) and by the shot of the ball at the opponent's goal, where the ball went near or over the goal or a goalkeeper caught or punched the ball ($p = 0.009$).

Key words: football, game interruption, putting the ball into play from the side, World Championship in 2010.

INTRODUCTION

One of the offensive interruptions of the game in football is putting the ball into play from the side. This group also includes putting the ball into play from the corner, free kicks, penalty kicks, ball throw in by a goalkeeper where the ball goes out of the field as a result of the opponent's shot and kick off shot at the beginning of the match, at the beginning of a second half of the match and after each scored goal.

Players with good technique and who are capable of putting the ball from into play from the side have a significant tactic advantage. By putting the ball from into play from the side players can achieve the same effects as though the ball was passed using a leg in the direction of opponent's goal (Aleksić, 1990).

One of the most recent examples of an efficient ball put into play from the side happened at the match

finalu lige šampiona u sezoni 2013/14. godine. Igrači domaće ekipe su postigli gol u neposrednom nastavku akcije posle izvedenog ubacivanja lopte u igru sa strane i zahvaljujući i tom голу ostvarili su plasman u polufinalu lige šampiona.

Bivši engleski fudbaler član F.K. "Stouk Siti" Rory Delop je bio poznat po "katapultu" u rukama. U karijeri je asistirao pri postizanju golova ubacivanjem lopte u igru sa strane kod 42 gola. Rekord u dužini izbačene lopte iz ruku mu je 45 metara, a prosek 38 metara. Matematičari i fizičari su izračunali da njegova lopta putuje brzinom od 60 km/h i da se kraće pod iglom od 20°. Pod tim uglom mišići leđa i ruku proizvode najveću silu. Svetski rekord u daljini izbačene lopte postigao je profesor fizičkog vaspitanja iz Yorkshirea Donny Brooks sa daljinom od 50 metara. Prethodni svetski rekord u ubacivanju lopte u igru rukom iznosio je 48 metara, a postavio ga je Amerikanac Michael Lochner (Miriam Bruckler i Cicvarić, 2008).

Jedna od karakteristika savremenog fudbala posmatranog i analiziranog naučnim tehnikama i metodama je i izračunavanje kontakt indeksa, a sa njim u vezi i odstupanja od teoretski najjednostavnije igre što se tiče broja dodira lopte prilikom rešavanja tehničko-taktičkih zadataka na terenu u fazi napada (Đošić, 2014.).

Jedan od ključnih preduslova za igranje fudbala na elitnom nivou je igranje sa što manjim brojem dodira lopte (Dellal et al, 2011; prema: San Román-Quintana, 2013.).

U prvoj ligi Srbije u timu F.K. "Bežanija" igrač Ljubo Baranin je poznat po ubacivanju lopte u igru sa strane u šešnaesterac protivnika pred gol. U poslednja dva prvenstva je postignuto više golova u nastavku akcije posle njegovog ubacivanja lopte sa strane. Za vreme igranja u Azerbejdžanu asistirao je ubacivanjem lopte u igru sa strane kod 29 postignutih golova.

Na Svetskom fudbalskom prvenstvu 1998. godine od ukupno 171 postignuta gola jedan je postignut u nastavku akcije posle izvedenog ubacivanja lopte u igru sa strane. Procentualno izraženo to iznosi 1,71% od ukupno postignutih golova (Bray, 2006).

Četiri prvoplasirane reprezentacije se statistički značajno razlikuju u dva od ukupno tri načina izvođenja ubacivanja lopte u igru iz ugla, a kod izvođenja slobodnih udaraca statistički značajna razlika postoji kod sva tri uobičajena načina izvođenja (Đošić, 2013, 2013a). Između istih reprezentacija statistički značajna razlika je utvrđena i kod odigravanja povratnih lopti sa jednim dodiranjem lopte istom igraču od koga je lopta i dobijena u zoni organizacije napada i zoni završnice napada (Đošić, 2013).

between Chelsea F.C. and Paris Saint-Germain F.C. in the quarterfinals of the Champions League in season 2013/14. Players of the home team scored a goal in a direct continuation of action, after the ball was put into play from the side, and due to that goal they went further into the semifinals of the Champions League.

A former English football player, member of the Stoke City F.C. Rory Delap was famous for having a catapult in his hands. In his career, he assisted in scoring goals by ball putting the ball into play from the side for 42 times. His record of throwing the ball is 45 meters, while the average is 38 meters. Mathematicians and physicists have calculated that, when he throws the ball, the speed is 60km/h and the ball flies at the angle of 20°. At this angle, muscles of the back and arms produce the largest force. The world record of the ball thrown in holds a professor of physical education Donny Brooks from Yorkshire, which is 50 meters. Previous record in throwing the ball was 48 meters and was achieved by an American Michael Lochner (Miriam Bruckler and Cicvarić, 2008).

One of the characteristics of modern football, which is observed and analyzed by scientific techniques and methods, is the calculation of a contact index, and in that respect the deviation of theoretically the simplest game regarding the number of ball touches when performing technical-tactical tasks on the field during the attack phase (Đošić, 2014.).

One of the key preconditions for playing elite football is playing with the least number of ball touches (Dellal et al, 2011; according to: San Román-Quintana, 2013.).

In the first Serbian league, the F.C. "Bežanija" football player Ljubo Baranin is well-known for his ball put into play from the side in the box in front of the opponent's goal. In the last two seasons, several goals have been scored in the continuation of action after he put the ball into play from the side. While his was playing in Azerbaijan, he assisted in scoring goals for 29 times using the ball put into play from the side. On the World Championship in 1998, out of 171 scored goals, one was scored as a result of the continuation of action after the ball was put into play from the side. Expressed in percentages it amounts to 1.71% of the total number of scored goals (Bray, 2006).

Four best ranked national teams statistically significantly differ in two out of three ways of putting the ball into play from the corner, and in terms of free kicks statistically significant difference exists in all three most common ways of performing the above mentioned (Đošić, 2013, 2013a). Statistically significant difference was determined in the same national teams in terms of backward pass with a single touch of the ball to the same player

METOD RADA

Posmatrani su DVD snimci utakmica finalista i polufinalista svetskog fudbalskog prvenstva 2010. godine. Ukupno 28 utakmica, po sedam utakmica svake reprezentacije.

Kao merni instrument primenjen je posmatrački list u koji su unošene frekvencije odigravanja pojedinih načina izvođenja, ishoda i ukupno izvedenih ubacivanja lopte u igru sa strane.

Uzorak varijabli

Ubacivanje lopte sa strane unapred prema голу protivnika (APGP).

- ❖ Ubacivanje lopte sa strane unazad prema svom голу (APSG).
- ❖ Ubacivanje lopte sa strane u šesnaesterac protivnika (AULŠ).
- ❖ Upućen šut prema голу protivnika posle ubacivanja lopte u igru sa strane, a lopta ode pored ili iznad gola ili je golman loptu uhvatio ili odbio (APGO).
- ❖ Upućen šut prema голу protivnika i postignut gol u nastavku akcije posle izvedenog ubacivanja lopte u igru sa strane (AŠPG).
- ❖ Ukupno izvedenih ubacivanja lopte sa strane (AUIA).
- ❖ Intervencija protivničke odbrane posle izvedenog ubacivanja lopte sa strane (AIPO).

Ubacivanje lopte sa strane se izvodi kada cela lopta pređe uzdužnu liniju terena po zemlji ili kroz vazduh. Lopta se ubacuje u igru u bilo kom pravcu sa mesta gde je prešla liniju. Ubacivanje lopte u igru vrši igrač ekipe koja nije poslednja igrala loptom. U trenutku kada ubacuje loptu igrač mora biti licem okrenut prema terenu, a delom stopala stajati na uzdužnoj liniji ili van nje. Pri ubacivanju lopte u igru igrač se mora služiti obema rukama i loptu ubaciti u teren sa obe ruke preko glave. Lopta je u igri čim uđe u teren, ali igrač koji je ubacuje ne sme da igra njom sve dok je neki drugi igrač ne dodirne ili njom ne igra. Pogodak ne može biti postignut neposredno iz ubacivanja lopte u igru sa strane.

Obrada prikupljenih podataka je obavljena statističkim softverom SPSS 20. Iz prostora deskriptivne statistike izračunati su: aritmetička sredina, standardna devijacija, maksimalna i minimalna vrednost. Za utvrđivanje razlika na nivou grupa primenjen je Kruskal Wallis test, a za testiranje razlika između parova reprezentacija Mann Whitney test.

who passed the ball in the phase of attack organization and in the phase of attack finalization (Došić, 2013).

METHOD

dVD recordings of the finalists and semifinalists of the World Championship in 2010 were observed; in total 28 matches, 7 matches of each national team. A record of frequency of performing the ball put into play from the side in certain ways, outcomes and a total number of balls put into play from the side was used as a measurement instrument.

Variables:

- ❖ Putting the ball into play from the side forward in the direction of opponents' goal (APGP).
- ❖ Putting the ball into play from the side backward in the direction of own goal (APSG).
- ❖ Putting the ball into play from the side in the opponent's „box“ (AULŠ).
- ❖ A shot towards the opponent's goal after the ball was put into play from the side, where the ball goes near the goal or over the goal or a goalkeeper catches or punches the ball (APGO).
- ❖ A shot at the opponent's goal and a scored goal in the continuation of action after the ball was put into play in from the side (AŠPG).
- ❖ The total number of putting the ball into play from the side (AUIA).
- ❖ The intervention of opponent's defense after the ball was put into play from the side (AIPO).

Putting the ball into play from the side is performed when the entire ball goes over the longitudinal line of the field whether the ball is on the ground or in the air. The ball can be thrown in any direction from the spot where it went over the line. Putting the ball into play from the side is performed by a player of the opposite team of that which touched the ball last. When putting the ball into play from the side, a player must face the field, and partially standing with one foot on the line or outside of it. When putting the ball into play from the side, a player must use his both hands and throw in the ball with both hands over his head. The match starts again when the ball enters the field, but the player who throws in the ball must not touch the ball until another player touches it. A goal cannot be scored by a direct ball put into play from the side.

The processing of collected data was performed by using statistical software SPSS 20. From the area of descriptive statistics, the following was calculated: arithmetic mean, standard deviation, maximum and minimum value. The Kruskal Wallis test was used for determining the differences at the group level, and for the testing of differences between the pairs of national teams the Mann Whitney test was used.

REZULTATI

Ukupno je na posmatranim utakmicama izvedeno 255 ubacivanja lopti u igru sa strane. Primenom strožijeg kriterijuma da u nastavku akcije posle izvedenog ubacivanja lopte sa strane učestvuje do tri igrača ekipe koja izvodi napad nijedna od analiziranih reprezentacija nije postigla gol u nastavku akcije posle izvedenog ubacivanja lopte sa strane. Primenom blažeg kriterijuma kojim se prihvataju golovi i iz akcija u kojima je učestvovalo i više igrača od trojice, jedino je reprezentacija Holandije postigla jedan gol posle tako izvedenog ubacivanja lopte u igru sa strane. U tabeli 1 se vidi da je na jednoj utakmici maksimalno izvedeno 18, a minimalno jedno ubacivanje lopte u igru sa strane na tzv. "protivničkoj" polovini terena odakle postoje realne mogućnosti da se u nastavku akcije posle ubacivanja lopte u igru sa strane postigne gol. Prosečno je izvedeno 9,16 ubacivanja lopti u igru sa strane na tzv. "protivničkoj" polovini terena. Prosečno je po utakmici izvedeno 4,07 ubacivanja lopte u igru sa strane ubacivanjem lopte unapred prema голу protivnika (APGP), 3,86 unazad prema svom голу (APSG) i najmanje ubacivanjem lopte u šesnaesterac protivnika (AULŠ), 1,21. Prosečno je posle izvedenih ubacivanja lopte u igru sa strane intervenisala i do lopte dolazila protivnička ekipa (AIPO) 7,25 puta po utakmici, a maksimalno su igrači protivničke ekipe došli do lopte na jednoj utakmici 16 puta.

Tabela 1. Deskriptivne karakteristike načina izvođenja i ishoda izvedenih ubacivanja lopte u igru sa strane

| | APGP | APSG | AULŠ | APGO | AIPO | AŠPG | AUIA |
|---------|------|------|------|------|------|------|------|
| N | 28 | 28 | 28 | 28 | 28 | 28 | 28 |
| Mean | 4,07 | 3,86 | 1,21 | 0,50 | 7,25 | 0,03 | 9,16 |
| St.dev. | 2,52 | 3,09 | 1,42 | 0,88 | 3,81 | 0,19 | 4,48 |
| Max. | 9 | 12 | 5 | 3 | 16 | 1 | 18 |
| Min. | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

Legenda: APGP- ubacivanje lopte u igru sa strane izvedeno ubacivanjem lopte unapred prema голу protivnika; APSG – ubacivanje lopte u igru sa strane izvedeno ubacivanjem lopte unazad prema svom голу; AULŠ- ubacivanje lopte u igru sa strane izvedeno ubacivanjem lopte u šesnaesterac protivnika; APGO –upučen šut prema голу protivnika posle ubacivanja lopte u igru sa strane, a lopta ode pored ili iznad gola ili je golman uhvati ili odbije; AIPO- intervencija protivničke odbrane posle ubacivanja lopte u igru sa strane; AŠPG- upućen šut prema голу protivnika i postignut gol u nastavku akcije posle ubacivanja lopte u igru sa strane; AUIA- ukupno izvedenih ubacivanja lopte u igru sa strane na posmatranim utakmicama.

RESULTS

In the course of observed matches, 255 ball put into play from the side were performed. By applying stricter criteria which means that in the continuation of action after the ball was put into play from the side three players of a team participate in the attack, none of the analyzed national teams scored a goal in the continuation of action after the ball was put into play from the side. By applying less strict criteria which means that the goals where more than three players participated were included in the analysis, only the national team of Holland scored a goal after putting the ball into play from the side. Table 1 shows that at one match maximum of 18, and minimum of 1 ball put into play from the side in the so-called "opponent's" half of the field were performed, therefore there is a realistic possibility that a goal can be scored in the continuation of action after the ball was put into play from the side. An average number of the ball put into play from the side in the so-called "opponent's" half of the field is 9.6. Per match, an average number of the ball put into play forward the opponent's goal (APGP) is 4.07, 3.86 backward in the direction of own goal (APSG) and the least number of the ball put into play is in the opponent's box (AULŠ). An opponent's team has intervened and came into the possession of the ball after putting the ball into play from the side (AIPO) 7.25 times on average per match, while the opponent's team players came into the possession of the ball 16 times maximum per match.

Table 1. Descriptive characteristics of ways of putting the ball into play from the side and the outcomes of putting the ball into play from the side

Legend: APGP- Ball put into play from the side forward in the direction of opponents' goal; APSG– Ball put into play from the side backward in the direction of own goal; AULŠ- Ball put into play from the side in the opponent's „box“; APGO–A shot towards the opponent's goal after the ball was put into play from the side, where the ball goes near the goal or over the goal or a goalkeeper catches or punches the ball; AIPO- The intervention of opponent's defense after the ball was put into play from the side; AŠPG- A shot at the opponent's goal and a scored goal in the continuation of action after the ball was put into play from the side; AUIA- The total number of putting the ball into play from the side at the observed matches.

U tabeli 2 su prikazani rezultati testiranja razlika u varijablama kod kojih je utvrđena statistički značajna razlika između posmatranih reprezentacija primenom Kruskall Wallis testa.

Tabela 2. Načini i ishodi ubačenih lopti u igru sa strane sa značajnim statističkim razlikama (Kruskall Wallis test)

| Varijabla / Variable | Reprezentacija / National team | χ^2 | p | df | Srednji rang / Medium rank |
|----------------------|--------------------------------|----------|-------|----|----------------------------|
| AULŠ | Španija / Spain | 13.900 | 0.003 | 3 | 6.00 |
| | Holandija / Holland | | | | 14.21 |
| | Nemačka / Germany | | | | 16.50 |
| | Urugvaj / Uruguay | | | | 21.29 |
| APGO | Španija / Spain | 12.517 | 0.006 | 3 | 10.50 |
| | Holandija / Holland | | | | 16.07 |
| | Nemačka / Germany | | | | 10.50 |
| | Urugvaj / Uruguay | | | | 20.93 |

Table 2 shows the results of testing the differences in variables, by using the Kruskall Wallis test, where a statistically significant difference between the observed national teams was determined.

Table 2. Methods and outcomes from putting balls into play from the side with significant statistical differences (Kruskall Wallis test)

Legenda: AULŠ- ubačena lopta u šesnaesterac protivnika sa strane; APGO –upućen šut prema голу protivnika posle ubacivanja lopte u igru sa strane, a lopta ode pored ili iznad gola ili je golman uhvati ili odbije.

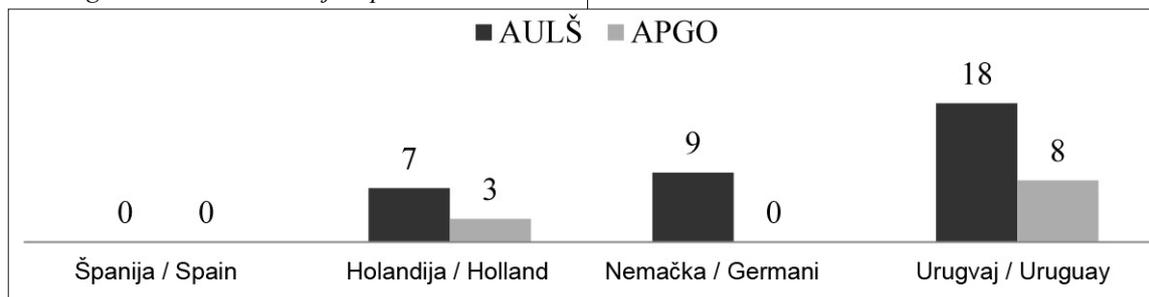
Legend: AULŠ-Ball put into play from the side in the opponent's „box“; APGO—A shot towards the opponent's goal after the ball was put into play from the side where the ball goes near the goal or over the goal or a goalkeeper catches or punches the ball.

Statistički značajna razlika je utvrđena samo kod dve varijable. Kod ubacivanja lopte u igru sa strane izvedenih ubacivanjem lopte u šesnaesterac protivnika (AULŠ) (p=0.003) i kod upućenih šuteva prema голу protivnika posle ubacivanja lopte u igru sa strane, a lopta ode pored ili iznad gola ili je golman uhvati ili odbije (APGO) (p=0.006).

Statistically significant difference was determined in two variables. By putting the ball into play from the side performed by the ball put into play in the opponent's box (AULŠ) (p=0.003) and by performed shoots to the opponent's goal after putting the ball into play from the side, where the ball goes near or over the goal or a goalkeeper catches or punches it (APGO) (p=0.006).

Grafikon 1. Ukupno ubačenih lopti u šesnaesterac protivnika sa strane i upućenih šuteva prema голу protivnika posle ubacivanja lopte u igru sa strane, a lopta ode pored ili iznad gola ili golman uhvati ili odbije loptu.

Graph 1. The total number of the ball put into play the opponent's box from the putting the ball into play from the side and shots at the opponent's goal after the ball was put into play from the side where the ball goes near or over the goal or a goalkeeper catches or punches it.



Legenda: AULŠ- ubačena lopta u šesnaesterac protivnika sa strane; APGO –upućen šut prema голу protivnika posle ubacivanja lopte u igru sa strane, a lopta ode pored ili iznad gola ili je golman uhvati ili odbije

U grafikonu 1 se vidi da reprezentacija Španije nije izvela nijedano ubacivanje lopte u igru sa strane ubacivanjem lopte u šesnaesterac protivnika, a isto i nijedan šut prema голу protivnika posle ubacivanja lopte u igru sa strane na tzv. "protivničkoj" polovini terena. Reprezentacija Urugvaja je izvela najviše ubacivanja lopte u igru sa strane ubacivanjem lopte u šesnaesterac protivnika i najviše šuteva prema голу protivnika, više od zbira ostale tri reprezentacije i što se tiče ubačenih lopti u šesnaesterac protivnika i što se tiče upućenih šuteva prema голу protivnika. Reprezentacija Urugvaja na ovom takmičenju nije postigla ni jedan gol u nastavku akcije posle izvedenog ubacivanja lopte u igru sa strane, ali je stvorila više dobrih šansi za postizanje gola i uputila više udaraca u i pred okvira gola protivnika.

U tabeli tri su prikazani rezultati Mann Whitney testa sa značajnim statističkim razlikama između parova reprezentacija u načinu izvođenja i ishodima izvedenih ubacivanja lopte u igru sa strane. Između reprezentacija Španije i Holandije su utvrđene statistički značajne razlike kod dva od ukupno tri evidentirana načina izvođenja ubacivanja lopte u igru sa strane $p < 0.05$, a u ishodima nisu pronađene statistički značajne razlike $p > 0.05$. Statistički značajne razlike su dobijene kod ubacivanja lopte u igru sa strane izvedenih ubacivanjem lopte unazad prema svom голу (APSG) ($p = 0.039$) i kod ubacivanja lopte u igru sa strane izvedenih ubacivanjem lopte u šesnaesterac protivnika (AULŠ) ($p = 0.008$).

Između reprezentacija Španije i Nemačke je dobijena statistički značajna razlika samo kod ubacivanja lopte u igru sa strane izvedenih ubacivanjem lopte u šesnaesterac protivnika (AULŠ) ($p = 0.008$). Između reprezentacija Španije i Urugvaja je dobijeno najviše razlika, kod ukupno tri varijable. Kod dve koje se odnose na način izvođenja ubacivanja lopte u igru sa strane i kod jedne koja se odnosi na ishod izvedenih ubacivanja lopte u igru sa strane.

From the graph it can be concluded that the Spain national team has not performed a single ball put into play from the side in the opponent's „box“, and the same result is for a shot towards the opponent's goal after the ball was put into play from the side in the so-called “opponent's” half of the field. The Uruguay national team has performed the biggest number of putting the ball into play from the side by the ball put into play in the opponent's box and the biggest number of shots towards the opponent's goal, which is more than a total number of other three national teams regarding the ball put into play from the side in the opponent's „box“ and a shot towards the opponent's goal. On this championship, the Uruguay national team has not scored a single goal in the continuation of action after the ball was put into play from the side, but has produced several good chances for scoring a goal and had several shots within and in front of the opponent's goal.

Table 3 shows the results of Mann Whitney test with statistically significant differences between the pairs of national teams in terms of the way of performing and the outcomes of performed putting the ball into play from the side. Between the national teams of Spain and Holland, statistically significant differences were determined in two out of three recorded ways of performing the putting the ball into play from the side $p < 0.05$, and in the outcomes no statistically significant differences were found $p > 0.05$. Statistically significant differences were found in putting the ball into play from the side performed by the ball put into play backward in the direction of own goal (APSG) ($p = 0.039$) and putting the ball into play from the side performed by the ball put into play in the opponent's „box“ (AULŠ) ($p = 0.008$).

Between the national teams of Spain and Holland, statistically significant differences were determined only in putting the ball into play from the side performed by the ball put into play in the opponent's „box“ (AULŠ) ($p = 0.008$).

The biggest number of differences was found between the national teams of Spain and Uruguay, namely in three variables in total: one is related to the way of putting the ball into play from the side and the other is related to the outcome of putting the ball into play from the side.

Tabela 3. Parovi reprezentacija i varijable sa značajnim statističkim razlikama (Mann Whitney test)

| Varijabla / Variable | Reprezentacija / National team | Z | Srednji rang / Medium rank | p |
|----------------------|--------------------------------|--------|----------------------------|--------------|
| | Španija / Spain | | 9.79 | |
| APSG | Holandija / Holland | -2.060 | 5.21 | 0.039 |
| | Španija / Spain | | 5.00 | |
| AULŠ | Holandija / Holland | -2.646 | 10.00 | 0.008 |
| | Španija / Spain | | 5.00 | |
| AULŠ | Nemačka / Germany | -2.646 | 10.00 | 0.008 |
| | Španija / Spain | | 10.14 | |
| APSG | Urugvaj / Uruguay | -2.404 | 4.86 | 0.016 |
| | Španija / Spain | | 4.00 | |
| AULŠ | Urugvaj / Uruguay | -3.364 | 11.00 | 0.001 |
| | Španija / Spain | | 5.00 | |
| APGO | Urugvaj / Uruguay | -2.622 | 10.00 | 0.009 |
| | Nemačka / Germany | | 5.00 | |
| APGO | Urugvaj / Uruguay | -2.622 | 10.00 | 0.009 |

Table 3. National team pairs and variables with statistically significant differences (Mann Whitney test)

Legenda: APSG – ubacivanja lopte u igru sa strane izvedena ubacivanjem lopte unazad prema svom голу; AULŠ- ubacivanja lopte u igru sa strane izvedena ubacivanjem lopte u šesnaesterac protivnika; APGO –upućen šut prema голу protivnika posle ubacivanja lopte u igru sa strane a lopta ode pored ili iznad gola ili je golman uhvati ili odbije;

Od načina izvođenja ubacivanja lopte u igru sa strane statistički značajna razlika je utvrđena kod izvođenja ubacivanjem lopte unazad prema svom голу (APSG) ($p=0.016$) i kod ubačenih lopti u šesnaesterac protivnika (AULŠ) ($p=0.001$). Kod ishoda ubačenih lopti u igru sa strane, statistički značajna razlika je utvrđena samo kod upućenih šuteva prema голу protivnika posle ubacivanja lopte u igru sa strane, a lopta ode pored ili iznad gola ili je golman uhvati ili odbije (APGO) ($p=0.009$).

Između reprezentacija Nemačke i Urugvaja statistički značajna razlika je utvrđena samo kod ishoda i to kod upućenih šuteva prema голу protivnika posle ubacivanja lopte u igru sa strane, a lopta ode pored ili iznad gola ili je golman uhvati ili odbije (APGO) ($p=0.009$).

Kod preostalih parova reprezentacija i kod ostalih varijabli nisu utvrđene statistički značajne razlike $p>0.05$.

Legend: APSG– Ball put into play from putting the ball into play from the side backward in the direction of own goal; AULŠ- Ball put into play from putting the ball into play from the side in the opponent's „box“; APGO–A shot towards the opponent's goal after the ball was put into play from the side, where the ball goes near the goal or over the goal or a goalkeeper catches or punches the ball.

In terms of the way of putting the ball into play from the side statistically significant difference was determined in the ball put into play from the side backward in the direction of own goal (APSG) ($p=0.016$) and in the ball put into play from the side in the opponent's „box“ (AULŠ) ($p=0.001$). In terms of the outcomes of putting the ball into play from the side, statistically significant difference was determined only in shots at the opponent's goal after the ball was put into play from the side, where the ball goes near the goal or over the goal or a goalkeeper catches or punches the ball (APGO) ($p=0.009$).

Between the national teams of Germany and Uruguay, statistically significant difference was determined only in the outcomes, namely, shots at the opponent's goal after the ball was put into play from the side, where the ball goes near the goal or over the goal or a goalkeeper catches or punches the ball (APGO) ($p=0.009$).

In the remaining national team pairs and other variables, no statistically significant differences were found $p>0.05$.

DISKUSIJA

Reprezentacija Španije pobednik Svetskog fudbalskog prvenstva 2010. godine nije izvela nijedno ubacivanje lopte u igru sa strane ubacivanjem lopte u šesnaesterac protivnika. To se može protumačiti kao njihova procena da su im takvim razvojem akcije male šanse za dolazak u povoljnu poziciju za upućivanje šuta prema голу protivnika i eventualno postizanje gola. Logična je pretpostavka da su se prilikom donošenja takve odluke rukovodili visinom svojih igrača iz manevarske i napadačke linije. Njihova je procena da su im veće šanse za dolaženje u povoljnu poziciju za upućivanje šuta prema голу protivnika i eventualno postizanje gola kroz kombinacije i zato je u njihovoj igri na posmatranim utakmicama evidentirano 72,30 % izvedenih ubačenih lopti u igru sa strane unazad prema svom голу (APSG), a 27,70 % izvedenih unapred prema голу protivnika ili uz liniju (APGP), a nijedno ubacivanje lopte u šesnaesterac protivnika (AUŠP).

Najviše ubacivanja lopte u igru sa strane izvedenih ubacivanjem lopte u šesnaesterac protivnika je izvela reprezentacija Urugvaja, a i najviše su igrači ove reprezentacije uputili šuteva prema голу protivnika posle ubacivanja lopte u igru sa strane. U nekim situacijama (šansama) su i santimetri nedostajali da lopta završi u mreži. Na osnovu „fudbalskih zakona“ koji su potvrđeni u decenijskoj praksi logično je pretpostaviti da će se reprezentaciji Urugvaja u budućnosti i rezultatski vratiti bar jedan deo na ovom takmičenju nerealizovanih šansi stvorenih posle izvođenja ubacivanja lopte u igru sa strane ubacivanjem lopte u šesnaesterac protivnika.

Jedan od problema u savremenom fudbalu, a koji je prisutan i decenijama unazad je i mala efikasnost, malo postignutih golova. Postizanje golova iz prekida igre direktno ili u nastavku akcije je samo jedan od načina postizanja golova. Analizirajući rezultate istraživanja koja su se bavila postizanjem golova iz prekida igre na prvenstvima sveta, uočava se da se najmanje golova postiže u nastavku akcija posle ubacivanja lopte u igru iz „auta“ (Janković i sar., 2010).

Retki su fudbaleri koji mogu loptu prilikom izvođenja ubacivanja lopte u igru sa strane da ubace ispred protivničkog gola i tako stvore svom timu povoljnu šansu za postizanje gola. Na osnovu rezultata ovog istraživanja vidi se da je od 255 izvedenih ubacivanja lopte u igru sa strane na tzv. „protivničkoj“ polovini terena postignut jedan gol i to primenom blažeg kriterijuma. Kako bi se povećao broj povoljnih situacija (šansi) za postizanje većeg broja golo-

DISCUSSION

The national team of Spain, the winner of World Championship in 2010, has not performed a single ball put into play from the side in the opponent's box. This can be interpreted as their assessment that under such circumstances the chances of creating a good opportunity to shoot at the opponent's goal and eventual scoring of a goal are slim. A logical assumption is that when making such decisions players take into account the height of their players from the maneuver and attack line. Their assessment is that they have bigger chances of creating a good opportunity to shoot at the opponent's goal and eventual scoring of a goal through the combinations, therefore in their game, on the observed matches 72.30% of the performed ball put into play from the side were directed backward to their own goal, (APSG), and 27.70% of the performed ball put into play from the side were directed towards the opponent's goal or along the line (APGP), while not a single ball put into play from the side was performed by the ball put into play the opponent's box (AUŠP).

The largest number of ball put into play from the side in the opponent's box was done by the Uruguay national team, and the players of this national team had the biggest number of shots at the opponent's goal after the ball was put into play from the side. In some situations (chances), the ball missed the goal only by centimeters. According to the "rules of football" confirmed by a decade-long practice, it is logical to assume that in the future, the national team of Uruguay will achieve some results as an outcome of unrealized chances on this championship, in particular chances created after the ball was put into play from in the side in the opponent's box. One of the problems in modern football, which is present for decades now, is poor efficiency, a small number of scored goals. Scoring goals after the interruption of game directly or in the continuation of action is only one of the ways of scoring goals. By analyzing the results of research, which aimed at analyzing scoring of goals on the world championships after the game was interrupted, it can be noted that the least number of goals was scored in the continuation of action after the ball was put into play from the side (Janković et al., 2010).

Individuals who can throw a ball in front of the opponent's box when putting the ball into play from the side are rare, hence they can rarely create a chance for their team to score a goal. Based on the results of this research, it is evident that out of 255 performed ball put into play from the side in the so-called opponents half of the field, one goal was scored where, in the analysis, a

va na fudbalskim utakmicama svih nivoa takmičenja predlog proistekao iz ovog istraživanja je da se „proba“ sa izvođenjem ubacivanja lopte u igru sa strane na tzv. „protivničkoj“ polovini terena nogom. Tako bi se povećala mogućnost da lopta češće dolazi ispred ili u šesnaesterac protivnika odakle su veće i realne mogućnosti za postizanje gola.

U nauci se za proveru pretpostavki primenjuje eksperiment. Predlog je da se u nekoj od nižih seniorskih liga ili ligi omladinaca uvede privremena promena pravila igre i dozvoli izvođenje ubacivanja lopte u igru sa strane na tzv. „protivničkoj“ polovini terena nogom u toku jedne takmičarske polusezone ili sezone i da se posebno evidentiraju postignuti golovi i stvorene šanse u nastavku akcije posle ubacivanja lopte u igru sa strane. Na kraju eksperimenta bi si pomoću osnovnih matematičkih operacija mogla utvrditi eventualna razlika i korist za povećanje efikasnosti na fudbalskim utakmicama izmenom pravila igre i eventualno bi se imali argumenti za predlog promena pravila fudbalske igre odgovarajućim fudbalskim telima na višim nivoima.

ZAKLJUČAK

Istraživanjem je utvrđena mala efikasnost ubacivanja lopte u igru sa strane na utakmicama finalista i polufinalista Svetskog fudbalskog prvenstva 2010. godine. Od 255 evidentiranih ubacivanja lopte u igru sa strane izvedenih na tzv. „protivničkoj“ polovini terena postignut je jedan gol i to primenom blažeg kriterijuma da u nastavku akcije prilikom postizanja gola posle izvedenog ubacivanja lopte u igru sa strane učestvuje više od tri igrača jedne ekipe. Statistički značajne razlike između reprezentacija finalista i polufinalista Svetskog fudbalskog prvenstva 2010. godine primenom Kruskall Wallis testa su dobijene kod ubacivanja lopte u igru sa strane izvedenih ubacivanjem lopte u šesnaesterac protivnika (AULŠ) ($p=0.003$) i kod upućenog šuta prema голу protivnika, a lopta ode pored ili iznad gola ili je golman uhvati ili odbije (APGO) ($p=0.009$).

Kako bi se povećao broj povoljnih situacija (šansi) za postizanje većeg broja golova na fudbalskim utakmicama svih nivoa takmičenja predlog za buduće istraživanje je da se dozvoli u eksperimentalnoj ligi izvođenje ubacivanja lopte u igru sa strane na tzv. „protivničkoj“ polovini terena nogom. Tako bi se povećala mogućnost da lopta češće

less strict criterion was used. In order to increase a number of chances for scoring a bigger number of goals at football matches of all levels, the suggestion, which is actually the result of this research, is to “try” to perform putting of the ball into play from the side in the so-called opponent’s half of the field by throwing in a ball using a leg. In that way, the possibility for a ball to be more frequently in front of or in the opponent’s box would increase, therefore creating a larger number of realistic opportunities for scoring goals.

In science, for the verification of the assumptions an experiment is used. The suggestion is to introduce a temporary change of the rules of the game in a certain lower senior league or junior league for a duration of one season or half of a season, where it would be permitted to perform ball put into play from the side in the so-called opponent’s half of the field by using a leg, and where the scored goals and created chances in the continuation of action after the ball was put into play from the side would be separately documented. At the end of the experiment, by using basic mathematical operations a possible difference and advantage of rules change in order to increase the efficiency at football matches could be determined, therefore the above mentioned could produce arguments for the suggestion of changing the rules of football game, which would be then presented to the appropriate football authorities of high level.

CONCLUSION

Research has confirmed poor efficiency of the ball put into play from the side at the matches of finalists and semifinalists of the World Championship in 2010. Out of 255 recorded ball put into play from the side performed in the so-called opponent’s half of the field, only one goal was scored, where a less strict criterion was used in the analysis, namely in the continuation of action when a goal was scored after the ball was put into play from the side more than three players of the same team participated in the action. Statistically significant differences between the national teams of finalists and semifinalists of the World Championship in 2010 were found by applying the Kruskall Wallis test, namely by putting the ball into play from the side in the opponent’s box (AULŠ) ($p=0.003$) and in shots toward the opponent’s goal, where the ball goes near or over the goal or a goalkeeper catches or punches it (APGO) ($p=0.009$).

In order to increase a number of chances for scoring a bigger number of goals at football matches of all levels, the suggestion for future research is to permit, in an experimental league to put in the ball into play from the side

dolazi ispred ili u šesnaesterac protivnika odakle su veće i realne mogućnosti za postizanje gola.

in the opponent's half of the field by using a leg. In that way, the possibility of a ball to be more frequently in front of or in the opponent's box would increase, which in return would increase the realistic possibilities of scoring a goal.

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