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OKSIDATIVNI STRES I FIZIČKA AKTIVNOST

OXIDATIVE STRESS AND PHYSICAL ACTIVITY

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SUMMARY

The cells continuously produce free radicals and reactive oxygen species as a part of metabolic processes. Increased aerobic metabolism during exercise is a potential source of oxidative stress. Also, anaerobic physical activity and oxidative stress are interrelated because the intense anaerobic activity leads to damage proteins, lipids and nucleic acids in muscle cells and blood. Complex system of antioxidant defense, which has the enzymatic and non-enzymatic part, has a role in protecting tissues from excessive oxidative damage. Most of the research conducted so far about the impact of various forms of physical activity on levels of oxidative stress is confirmed by changes in biomarkers that indicate lipid peroxidation and proteins modification. Untrained persons, as opposed to trained, are more susceptible to major changes in the body caused by oxidative stress during physical activity. The results of researches have shown that there are no significant differences between the genders in the level of oxidative stress during physical activity and response to antioxidant supplementation possibly applied. It is interesting that, despite of numerous studies, the exact location of oxidative stress origin during physical activity has not been reliably established. In addition, research results provide insufficient evidence on the effectiveness of using antioxidant supplementation to increase the defense against oxidative stress. It is necessary further investigation about the redox status and oxidative stress during physical activity in adolescent athletes.

Key words: physical activity, oxidative stress, antioxidants.

SAŽETAK

Ćelije stalno proizvode slobodne radikale i reaktivne vrste kiseonika kao dio metaboličkih procesa. Povećani aerobni metabolizam tokom fizičke aktivnosti potencijalni je izvor oksidativnog stresa. Takođe, anaerobna fizička aktivnost i oksidativni stres međusobno su povezani jer intenzivna anaerobna aktivnost vodi ka oštećenjima proteina, lipida i nukleinskih kiselina u mišićnim ćelijama i krvi. Složeni sistem antioksidantne odbrane, koji ima enzimski i neenzimski dio, ima ulogu u zaštiti tkiva od prevelikih oksidativnih oštećenja. Većina do sada sprovedenih istraživanja o uticaju različitih oblika fizičke aktivnosti na nivo oksidativnog stresa potvrđuje promjene u biomarkerima koji ukazuju na lipidnu peroksidaciju i modifikacije na proteinima. Osobe koje ne treniraju, za razliku od onih koji treniraju, podložnije su većim promjenama u organizmu uzrokovanim oksidativnim stresom pri fizičkoj aktivnosti. Rezultati ciljanih istraživanja su pokazali da nema bitnih razlika između polova u nivou oksidativnog stresa pri fizičkoj aktivnosti i odgovoru organizma na eventualno primjenjenu antioksidantnu suplementaciju. Interesantno je da i pored brojnih studija, tačna lokacija nastanka oksidativnog stresa pri fizičkoj aktivnosti još uvijek nije pouzdano utvrđena. Uz navedeno, rezultati sprovedenih istraživanja pružaju nedovoljno dokaza o efektivnosti upotrebe antioksidantne suplementacije u cilju povećanja odbrane od oksidativnog stresa. Neophodno je detaljnije istražiti redoks status i oksidativni stres pri fizičkoj aktivnosti i kod sportista adolescenata.

Ključne riječi: fizička aktivnost, oksidativni stres, antioksidansi.

INTRODUCTION

The cells continuously produce free radicals and reactive oxygen species (ROS) as a part of the metabolic processes. Free radicals are defined as molecules or parts of molecules that have one or more odd number of electrons in the outer cloud layer. They are characterized by a very short half-life and particularly high degree of reactivity. Harmful effects of free radicals originate from their innate tendency to get to the stage of electronic stability thus reacting with the first neighboring stable molecule taking away an electron and creating a new free radical. The affected molecule becomes unstable itself and enters into reaction with other molecules it gets near to, which results in disruption of cell components. Free radicals are created primarily during the process of oxidative phosphorylation in mitochondria (Martinović, Dopsaj, Kotur Stevuljević, & Nešić, 2009). The highest number of free radicals emerging in vitro are or originate from reactive oxygen species (superoxide, hydroxyl, alkoxyl, peroxyl and hydroperoxyl) or reactive nitrogen species (nitric oxide, nitrogen dioxide, peroxynitrite oxidized) (Cooper, Vollaard, Choueiri, & Wilson, 2002). As a counterweight to the emerging of free radicals there is a system of antioxidant protection which can be divided into two sections: enzymatic – composed of superoxide dismutase (SOD), catalase (CAT), paraoxonase and glutathione peroxidase (GPX); and non-enzymatic – composed of the substances such as: vitamins A and C, retinol, bilirubin, uric acid, reduced glutathione, thiols, coenzyme Q10, stress proteins, albumin, as well as transport proteins and proteins responsible for Fe^{2+} i Cu^{2+} deposition (transferrin – iron-carrying proteins in plasma and ferritin – a protein that is used to store intracellular iron, keeping it in soluble and nontoxic state), which bind potentially hazardous metal ions and disable their participation in production of free radicals (Martinović et al., 2009). Antioxidant enzymes are endogenous and their formation may be altered by certain factors. The factors of increased production of enzymatic antioxidants include physical activity and training (Finaud, Lac, & Filaire, 2006).

Physiologists' filed of interest was earlier limited only to the matter of oxygen supply, especially for those who studied the response of organism to physical activity. However, the interest in oxygen radicals has increased as soon as the oxidative paradox was discovered, which motivated them to raise the issue whether the excessive oxygen supply during exercise can lead to oxidative stress and potential risks for biological system. (Jenkins, 2000).

The first indications that physical activity results in tissue damage caused by means of free radicals

UVOD

Ćelije stalno proizvode slobodne radikale i reaktivne vrste kiseonika (RVK) kao dio metaboličkih procesa. Slobodni radikali su molekuli ili dijelovi molekula koji imaju jedan ili više nesparenih elektrona u spoljašnjem elektronskom omotaču. Osnovne osobine ovih molekula su veoma kratak poluživot i izuzetno velika reaktivnost. Štetno djelovanje slobodnih radikala potiče iz potrebe da postignu elektronsku stabilnost i zato reaguju sa prvim susjednim stabilnim molekulom, uzimajući njegov elektron i stvarajući novi slobodni radikal. Tako susjedni molekul i sam postaje nestabilan i dalje ulazi u reakcije sa drugim molekulima iz okruženja što rezultira oštećenjem ćelijskih komponenata. Slobodni radikali se stvaraju prvenstveno tokom procesa oksidativne fosforilacije u mitohondrijama (Martinović, Dopsaj, Kotur Stevuljević i Nešić, 2009). Najveći broj slobodnih radikala koji se javljaju in vitro su ili nastaju od reaktivnih vrsta kiseonika (superoksid, hidroksil, alkoksil, peroksil i hidroperoksil) ili reaktivne vrste azota (azot monoksid, azot dioksid, peroksinitrit oksid) (Cooper, Vollaard, Choueiri i Wilson, 2002). Kao protivteža nastajanju slobodnih radikala u organizmu postoji sistem antioksidantne zaštite i on se može podeliti na dve celine: enzimski, koga čine superoksid dimutaza (SOD), katalaza (CAT), paraoksonaza i glutation peroksidaza (GPX); i neenzimski, koji podrazumeva učešće supstanci kao što su: vitamini C i E, retinol, bilirubin, mokraćna kiselina, redukovani glutation, tioli, koenzim Q10, stres proteini, albumin kao i transportni proteini i proteini odgovorni za deponovanje Fe^{2+} i Cu^{2+} (transferin-transportni protein gvožđa u plazmi i feritin-deponuje gvožđe unutarćelijski održavajući ga u rastvorljivom i netoksičnom stanju) koji vezuju potencijalno opasne metalne jone i onemogućavaju njihovo učešće u produkciji slobodnih radikala (Martinović i saradnici, 2009). Antioksidantni enzimi su endogeni i njihovo nastajanje može biti izmijenjeno određenim faktorima. Poznati potencijalni faktori povećane produkcije enzimskih antioksidanata su fizička aktivnost i trening (Finaud, Lac i Filaire, 2006).

Fiziolozi koji proučavaju odgovor organizma na fizičku aktivnost ranije su se primarno bavili problemom dotoka kiseonika. Međutim, interesovanje grupe naučnika za kiseonične radikale poraslo je sa otkrićem oksidativnog paradoksa i motivisalo ih da postave pitanje: da li preveliki dotok kiseonika usljed fizičke aktivnosti može izazvati oksidativni stres i rizike po biološki sistem (Jenkins, 2000).

Prve naznake da fizička aktivnost rezultuje i oštećenjima na tkivima posredstvom slobodnih radikala

appeared in 1978, so the remaining three decades witnessed a significant increase in knowledge on that particular matter. It is well known that both active and inactive skeletal musculature produce reactive oxygen and nitrogen species though it still remains unclear the exact place of origin of oxidants during exercise (Powers & Jackson, 2008).

Free radicals get neutralized if exposed to a complex system of antioxidant defense system (Urso & Clarkson, 2003). Enzymatic and non-enzymatic antioxidants play an important role in tissue protection caused by excessive oxidative damage. This is particularly emphasized during exercise since physical activity is related to the production of free radicals in terms of intensity and duration of exercise as well as the physical condition of a human body. In case a low intake of antioxidants through diet and modification of antioxidant system takes place, antioxidant nutrient food supplements are established to be beneficial (Jones, 2008). However, the theoretical basis according to which antioxidants should improve athletic performance has not been clarified. In general, the research have confirmed that antioxidant supplements do not improve athletic performance but only the antioxidant status. On the other hand, higher amounts of antioxidants in regular diet may yield negative effects. Therefore, the composition, duration of intake and proper dosage of antioxidant supplements are to be conducted in a strictly controlled manner (Finaud et al., 2006).

METHODS FOR OXIDATIVE STRESS ASSESSMENT

Oxidative stress may be examined by measuring the following:

- Free radicals;
- Damage to lipids, proteins and DNA molecules caused by the effects of free radical formation;
- Activity of enzymatic antioxidants.

Measurement of free radicals

The production of reactive oxygen species can be measured by the means of spectroscopic method. Still, this method is not the most appropriate on humans due to the toxicity of materials used during this process. The examination is therefore conducted by taking blood samples, which initially get exposed to stabilizer of reactive oxygen species then centrifuged and finally the serum gets analyzed spectroscopically. Here the problem is that the application of this method cannot avoid the short half-life of the reactive oxygen species.

pojavile su se 1978. godine, tako da je u posljednje tri dekade zabilježen veliki prirast u znanjima o fizičkoj aktivnosti i oksidativnom stresu. Dobro je poznato da i aktivna i neaktivna skeletna muskulatura proizvodi reaktivne vrste kiseonika i azota iako se još uvijek ne zna tačno mjesto nastanka oksidanata tokom fizičke aktivnosti (Powers i Jackson, 2008).

Slobodni radikali bivaju neutralisani složenim sistemom antioksidantne odbrane (Urso i Clarkson, 2003). Enzimski i neenzimski antioksidanti igraju značajnu ulogu u zaštiti tkiva od prevelikih oksidativnih oštećenja. Ovo je posebno važno tokom fizičke aktivnosti, s obzirom da je fizička aktivnost povezana sa proizvodnjom slobodnih radikala i to u zavisnosti od intenziteta i trajanja fizičke aktivnosti, kao i stanja utreniranosti organizma. Zbog niskog unosa antioksidanata kroz ishranu i modifikacija antioksidantnog sistema tokom fizičke aktivnosti, potvrđena je korist od suplementacije nekih antioksidantnih nutritijenata (Jones, 2008). Međutim, teorijska osnova po kojoj bi antioksidanti trebalo da poboljšaju sportske rezultate nije razjašnjena. Istraživanja su generalno potvrdila da antioksidantni suplementi ne poboljšavaju sportske rezultate već samo antioksidantni status. S druge strane, velike količine antioksidanata u ishrani mogu imati negativne efekte. Dakle, sastav, trajanje i doze antioksidantnih suplemenata moraju biti strogo kontrolisani (Finaud i saradnici, 2006).

METODE ZA PROCJENU OKSIDATIVNOG STRESA

Oksidativni stres se može ispitati mjerenjem:

- Slobodnih radikala;
- Oštećenja na lipidima, proteinima i DNK molekulima uzrokovanih dejstvom slobodnih radikala;
- Aktivnosti enzimskih antioksidanata.

Merenje slobodnih radikala

Proizvodnja reaktivnih vrsta kiseonika može biti određena direktno pomoću spektroskopske metode. Međutim, ovaj metod nije najprimenjiviji za ispitivanja na ljudima zbog toksičnosti materija koje se koriste. Za ispitivanje ovom metodom uzimaju se uzorci krvi koji se najprije izlažu dejstvu stabilizatora reaktivnih vrsta kiseonika, a zatim se centrifugiraju i serum spektroskopski analizira. Problem u primjeni ove metode je i u kratkom vremenu poluživota reaktivnih vrsta kiseonika.

Measurement of oxidative damage on lipids, proteins and DNA molecules

The negative effects of free radicals can be manifested on various biomolecules (lipids, proteins and DNA molecules), and as a result of their interaction there is an increased permeability of cell membranes alongside with accelerated catabolism of proteins and gene mutation (Martinović et al., 2009).

Lipid peroxidation

The basis for measurement of oxidative stress is the measurement of the level of lipid peroxidation in the cell membrane. The lipid peroxidation decomposes lipids onto a large number of primary oxidative products such as conjugated dienes (lipid hydroperoxidase), and secondary oxidative products including malondialdehyde (MDA), F2-isoprostane or exhaled pentane, hexane or ethane. The measurement of conjugated dienes, as primary products of lipid peroxidation, is often used for this purpose.

MDA is also used in measurement of oxidative stress though it should not be the first choice in research since it is only a secondary product. This substance originates in the course of autoxidation of fatty acids. It is common to be measured through its reaction with thiobarbituric acid.

In addition to thiobarbituric acid, the concentration of thiobarbituric reactive species is often used as index of lipid peroxidation (TBARS) (Čubrilo et al., 2011).

Another way to examine oxidative damage on lipids is the analysis of pentane, hexane and ethane in the exhaled air. This is a non-invasive method but still insufficiently precise because the mentioned gasses may originate in other ways, not just by means of oxidation.

The most recent finding indicate that F2-isoprostanes, while undergoing peroxidation, produce arachionic acids, which are catalyzed by free radicals. Some studies show that quantification of F2-isoprostane can be a reliable method in assessment of endogenous lipid peroxidation and oxidative damage as well as other blood markers, namely oxidized LDL or antibodies for oxidized LDL.

Protein modifications

Modifications on proteins caused by free radicals induce the formation of carbonyl groups at spots in chains where amino groups are located. The increased amount of carbonyl is linked to oxidative stress. That is why the measurement of carbonyls is the method most commonly used in determining the degree of the oxidative damage on proteins. For more precise measurement of protein oxidation carbonyl/protein ratio is used. This method is more

Mjerenje oksidativnih oštećenja na lipidima, proteinima i DNK molekulima

Negativni efekti djelovanja slobodnih radikala ispoljavaju se na različitim biomolekulima (lipidima, proteinima i DNK molekulima), a posljedica njihove interakcije je povećana propustljivost ćelijske membrane, ubrzan katabolizam proteina i genske mutacije (Martinović i saradnici, 2009).

Lipidna peroksidacija

Osnova mjerenja oksidativnog stresa jeste mjerenje nivoa peroksidacije lipida u ćelijskoj membrani. Lipidna peroksidacija izaziva razgradnju lipida na veliki broj primarnih oksidativnih produkata, kao što su konjugovani dieni (lipid hidroperoksidaze), i sekundarnih oksidativnih produkata uključujući tu malondialdehid (MDA), F2-izoprostan ili izdahnuti pentan, heksan ili etan. Često se primjenjuje mjerenje konjugovanih diena, kao primarnih produkata lipidne peroksidacije.

MDA se takođe često koristi u istraživanjima, mada ne bi trebalo da ima primat s obzirom da je sekundarni produkt. Ova supstanca nastaje tokom autooksidacije masnih kiselina. Uobičajeno je da se ona mjeri kroz svoju reakciju sa tiobarbituratnom kiselinom.

Osim toga, kao indeks lipidne peroksidacije često se koristi i koncentracija tiobarbituratskih reaktivnih vrsta (TBARS) (Čubrilo i saradnici, 2011).

Još jedna od tehnika za ispitivanje oksidativnih oštećenja lipida je analiza pentana, heksana i etana u izdahnutom vazduhu. Ovo je neinvazivna metoda, ali je nedovoljno precizna s obzirom da ovi gasovi mogu nastati i na drugi način a ne samo oksidacijom.

Skoro je potvrđeno da se F2-izoprostani proizvode peroksidacijom arahionske kiseline i to katalisano slobodnim radikalima. Studije pokazuju da kvantifikovanje F2-izoprostana može biti pouzdan metod za procjenu endogene lipidne peroksidacije i oksidativnih oštećenja, kao što to mogu biti i drugi markeri u krvi npr. oksidovan LDL ili antitijela za oksidovani LDL.

Proteinske modifikacije

Modifikacije na proteinima uzrokovane slobodnim radikalima, izazivaju formiranje karbonilnih grupa na mjestima u lancu gde su amino-grupe. Povećana količina karbonila povezana je sa oksidativnim stresom. Zato je mjerenje nastalih karbonila metod koji se najčešće koristi za određivanje oksidativnih oštećenja na proteinima. Za još preciznije određivanje oksidacije proteina koristi se karbonil/protein odnos. Ovaj metod ima veliku prednost s obzirom na dugo vrijeme

beneficial due to the long period of half-life of carbonyl. Besides, the high amount of carbonyl may reveal cumulative effects of oxidative stress, which is of crucial importance for studies dealing with longitudinal observation of the subject.

The alternative method is the quantification of oxidized amino acid (e.g. o-o-dityrosine). The advantage of this method lies in the fact that it is non-invasive (urine sample), but the interpretation of the obtained results is limited.

Modifications on DNA molecules

Reactive oxygen species cause several types of damage on DNA molecules: chain breaks, damages on protein bonds and basic modifications. Numerous methods are used to quantify these damages. The most applicable one is the method of the marker nucleotide 8-hydroxy-2-deoxyguanosine (8-OHdG), which originates in oxidation of a guanine caused by a free radical.

Other indirect markers of oxidative stress

Creatine kinase (CK) and myoglobin are markers of cell muscle damage. These markers can also be the indirect markers of oxidative stress because the lipid peroxidation causes damage on cell membrane. However, creatine kinase and myoglobin are not the specific markers of oxidative stress especially among athletes that have a high percentage of these substance due to the athletic characteristics (e.g. physical contact), which may cause cell damage. Moreover, trained sportsmen record higher basal value of both of these substances.

Measuring antioxidants

- Enzymatic antioxidant activity (SOD, CAT, GPX) is often examined in various research. This method is valid if we need to evaluate the quality of antioxidant defense of an organism at rest, but it also can account for the importance of oxidative stress especially after the physical activity.
- Quantification of antioxidant vitamins (A, C i E) in plasma is a common method for assessment of antioxidant defense and vitamin (A, C and E) insufficiency. Same as the antioxidant enzymes, the concentration of antioxidant vitamins is changed as a result of the oxidative stress and can therefore be used as an indirect marker of the oxidative stress.
- Other antioxidants that can be used for oxidative stress measuring include: thiol protein (GSH as the most important thiol protein in our body and GSSH as its oxidized form), uric acid (insufficiently reliable), allantoin (as an oxidized product of uric acid).

poluživota karbonila. Pored toga, visoka količina karbonila može pokazati kumulativne efekte oksidativnog stresa, što je od presudne važnosti u studijama koje se bave longitudinalnim praćenjem subjekata.

Alternativni metod koji se koristi je kvantifikovanje oksidovane aminokiseline (npr. o-o-ditirozin). Prednost ovog metoda je u tome što je to neinvazivni metod (uzorak urina), ali je interpretacija na ovaj način dobijenih rezultata ograničena.

Modifikacije na DNK molekulima

Reaktivne vrste kiseonika uzrokuju nekoliko tipova oštećenja na DNK molekulima: kidanje lanaca, oštećenja na proteinskim vezama i bazične modifikacije. Brojni metodi se koriste za kvantifikovanje ovih oštećenja, a najčešće korišćen marker je nuklotid 8-hidroksi-2-deoksiguanozin (8-OHdG) koji nastaje oksidacijom guanine, izazvanom slobodnim radikalima.

Ostali indirektni markeri oksidativnog stresa

Kreatin kinaza (CK) i mioglobin su markeri ćelijskog mišićnog oštećenja. Ovi markeri mogu takođe biti i indirektni markeri oksidativnog stresa s obzirom da lipidna peroksidacija izaziva oštećenja ćelijskih membrana. Međutim, kreatin kinaza i mioglobin nisu specifični markeri oksidativnog stresa posebno kod sportista koji imaju visok nivo ovih supstanci zbog sportskih karakteristika (udarci, kontakti) koje izazivaju ćelijska oštećenja. Uz to, trenirani sportisti imaju više bazalne vrijednosti obje supstance.

Mjerenje antioksidanata

- Enzimska antioksidantna aktivnost (SOD, CAT, GPX) često se ispituje u istraživanjima. Ovaj metod može vrednovati kvalitet antioksidantne odbrane organizma u mirovanju, ali takođe može pokazati i važnost oksidativnog stresa, posebno nakon fizičke aktivnosti.
- Kvantifikovanje antioksidantnih vitamina (A, C i E) u plazmi je uobičajen metod za procjenu antioksidantne odbrane i utvrđivanja nedostatka pomenutih vitamina. Isto kao antioksidantni enzimi i koncentracija antioksidantnih vitamina se mijenja usljed oksidativnog stresa i može se koristiti kao indirektni marker oksidativnog stresa.
- Drugi antioksidanti koji se mogu koristiti u tehnikama određivanja oksidativnog stresa su: tiol-proteini (GSH kao najvažniji tiol-protein u GSH), mokraćna kiselina (nedovoljna pouzdanost), alantoin (kao oksidovani proizvod mokraćne kiseline).

- Measuring the total antioxidant capacity (TAC-total antioxidant capacity), which gives an insight into the scope of the response of all antioxidants taken together (Finaud et al., 2006).

- Mjerenje ukupnog anioksidatnog kapaciteta (TAC- total antioxidant capacity) koji govori o veličini odgovora svih antioksidanata (Finaud i saradnici, 2006).

OXIDATIVE STRESS AND PHYSICAL ACTIVITY

The physical activity is considered to lead to an increase in the production of reactive oxygen species potentially causing cell damage. Stress proteins represent one of the general protective mechanisms which enable the cells and the organism to overcome stress. The precise relationship between physical activity, stress proteins and reactive oxygen species still remains unknown. Up-to-date information from different research are insufficient if an antioxidant food supplement is to be recommended for either athletes of physically active persons (Radovanović & Ranković, 2004).

Intensive physical activity causes oxidative stress by all means. There is no evidence this leads to short--term effects on athletic performance though it may have long-term but not necessarily damaging effects on health. In a study conducted in 2001, it was emphasized that mitochondria in the muscle cells represent an important source of reactive substances (intermediates) such as: superoxide, hydrogen peroxide and probably hydroxyl radical. The study proved that mitochondria can even produce nitric oxide, which is also related to the production of oxidants mitochondrial function (Leeuwenburgh & Heinecke, 2001). A study conducted in vitro indicates that mitochondria may play a minor role in the creation of free radicals whereas Hem proteins are increasingly more important in terms of oxidative stress induction. The interaction between metmyoglobin and methemoglobin with peroxides can be a significant source of the oxidative stress during (Cooper et al., 2002).

Aerobic exercise

Davies, Quintanilha, Brooks, and Packer (1982), were first to prove that physical activity increased the production of free radicals. Many following studies dealt with the effects of exercise on the oxidative stress. They were predominantly concerned with the following sports: running, swimming and bicycling. The aerobic exercise was found to be linked to the increase in oxygen consumption VO_2, which resulted in an increase in both free radical production and activity. However, it was observed that such a phenomenon was not evident at exercising of low intensity (<50% VO_2max). In that case the antioxidant capacity was not surpassed and damages induced by free

OKSIDATIVNI STRES I FIZIČKA AKTIVNOST

Smatra se da fizička aktivnost dovodi do povećanja stvaranja reaktivnih vrsta kiseonika što može dovesti do oštećenja ćelija. Stres proteini predstavljaju jedan od opštih zaštitnih mehanizama koji omogućavaju ćeliji i cijelom organizmu da preživi stres. Tačna povezanost fizičke aktivnosti, stres proteina i reaktivnih vrsta kiseonika još uvek je nepoznata. Do sada poznati podaci iz različitih istraživanja nedovoljni su da bi se suplementacija antioksidansima preporučivala sportistima ili fizički aktivnijim osobama (Radovanović i Ranković, 2004).

Intenzivna fizička aktivnost uzrokuje oksidativni stres. Nema dokaza da to ima negativne kratkoročne efekte na takmičarsku uspješnost, iako može imati dugoročne, ne obavezno i štetne posljedice po zdravlje. U studiji iz 2001. godine naglašeno je da su mitohondrije u mišićnim ćelijama važan izvor reaktivnih supstanci (intermedija) kao što su: superoksid , hidrogen-peroksid i vjerovatno hidroksil-radikal. Dokazano je da mitohondrija može proizvesti i azotni oksid koji je takođe povezan sa produkcijom oksidanata i funkcijom mitohondrija (Leeuwenburgh i Heinecke, 2001). Studija izvedena in vitro, ukazuje na mogućnost da mitohondrije imaju manju ulogu u stvaranju slobodnih radikala, sve se više prihvata važnost hem-proteina u izazivanju oksidativnog stresa. Interakcija metmioglobina i methmoglobina sa peroksidima može biti važan izvor oksidativnog stresa tokom fizičke aktivnosti (Cooper i saradnici, 2002).

Aerobna fizička aktivnost

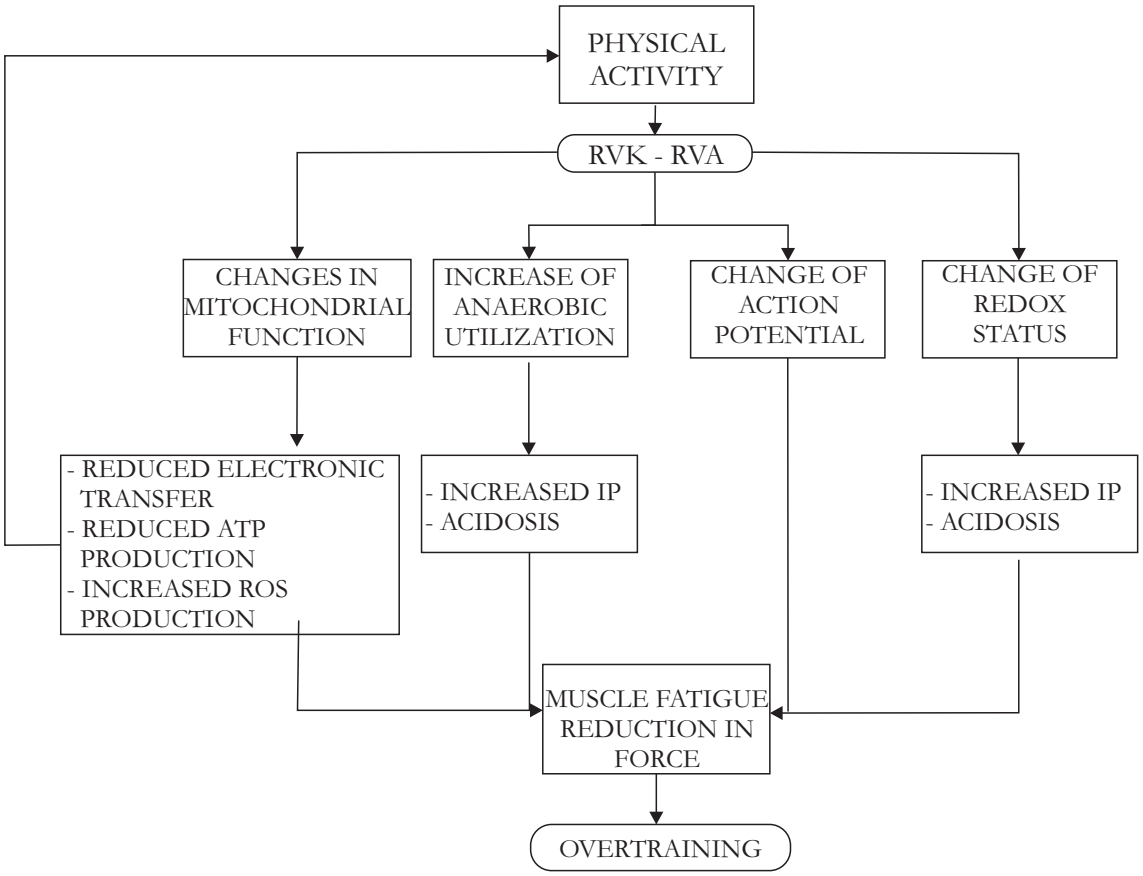
Davies, Quintanilha, Brooks i Packer (1982) su prvi dokazali da fizička aktivnost povećava proizvodnju slobodnih radikala. Nakon toga, mnoge su studije proučavale efekte fizičke aktivnosti na oksidativni stres, a u velikom broju njih je primijenjena aerobna fizička aktivnost (trčanje, plivanje, biciklizam). Aerobna fizička aktivnost povezana je sa povećanjem potrošnje kiseonika VO_2 što utiče na povećanje proizvodnje i aktivnosti slobodnih radikala. Međutim, uočeno je da se ovaj fenomen ne javlja kod fizičke aktivnosti niskog inteziteta (<50% VO_2max). U tom slučaju antioksidantni kapacitet se ne nadmašuje i ne pojavljuju se oštećenja

FIGURE 1

Hypothetical model of reactive oxygen species effect on muscle fatigue (modified according to Finaud et al., 2006).

SLIKA 1

Hipotetički model efekata reaktivnih vrsta kiseonika na mišićni zamor (modifikovano prema Finaud i saradnici, 2006).



Legend: **ATP** – Adenosine triphosphate (Adenozin trifosfat); **IP** – Inorganic phosphate (Neorganski fosfati); **RNS** – Reactive nitrogen species (Reaktivne vrste azota); **ROS** – Reactive oxygen species (Reaktivne vrste kiseonika); Physical activity - Fizička aktivnost; Changes in mitochondrial function - Promena funkcije mitohondrija; Increase of anaerobic utilization - Povećanje anaerobne utilizacije; Change of action potential - Promjena akcionog potencijala; Change of redox status - Izmjena redoks stanja; Reduced electronic transfer - Smanjen elektronski transfer; Reduced ATP production - Smanjeno stvaranje ATP; Increased ROS production - Povecano stvaranje RVK; Increased IP - Povećan NF; Acidosis - Acidoza; Muscle fatigue - Mišićni zamor; Reduction in force- Smanjenje sile; Overtraining - Pretreniranost.

radicals did not take place. The production of free radicals and oxidative stress were higher if a more intensive physical activity was to be applied.

The increased aerobic metabolism during exercise is potentially a source of the oxidative stress. Since the health benefits of regular exercising are well-known, the possibility of the oxidative stress reduction caused by the adaptation to physical activity was looked into. That implied the increase of antioxidant defense, decrease of basal production of

uzrokovana slobodnim radikalima. Produkcija slobodnih radikala i oksidativni stres veći je sa primjenom intezivnije aerobne fizičke aktivnosti.

Povećani aerobni metabolizam tokom fizičke aktivnosti potencijalni je izvor oksidativnog stresa. S obzirom da su zdravstvene pogodnosti redovne fizičke aktivnosti poznate, ispitana je mogućnost smanjenja oksidativnog stresa usled adaptacije na fizičku aktivnost. Ovo podrazumeva povećanje antioksidantne odbrane,

antioxidant production, and reduced loss of radicals during oxidative phosphorylation (Leeuwenburgh & Heinecke, 2001).

The increased production of reactive oxygen and nitrogen species as well as oxidative stress occur among top athletes when exposed to the maximum load regardless of the type of energetic demand of a particular sport (aerobic, aerobic-anaerobic, anaerobic). The effects of longtime training of various sports (bicycling, rowing and taekwondo) onto the parameters of the oxidative stress at rest have been examined. The progressive loading test in its interval from the fourth to tenth minute of resting has been applied for this purpose. The results of the study have showed that training practice of various sports affects the establishment of different basal level of nitrite and concentration of thiobarbituric reactive species (TBARS) in such a manner that taekwondo records the lowest level of nitrite, followed by bicycling and rowing with the highest level of nitrite, whereas in terms of TBARS level rowing has the lowest level followed by taekwondo and bicycling. However, in terms of the level of parameters of the oxidative stress, no significant difference has been determined regardless of the type of sport and irrespective of the ten minute long resting period (Čubrilo et al., 2011).

Although the benefits of anaerobic physical activity cannot be disputed, there is plenty of evidence that a high intensity anaerobic physical activity leads to oxidative stress. The prolonged and intensive anaerobic exercise drastically affects the increase of reactive oxygen species production, which results in antioxidant insufficiency and leads to the oxidative stress, cell mutations, tissue and immune system damage.

The anaerobic physical activity and oxidative stress are closely linked in the sense that the intensive anaerobic physical activity results in damage of proteins, lipids and nucleic acids in muscle cells and blood. There is evidence that regular anaerobic physical activity increases the oxidative stress. Large number of research abounds in details on aerobic physical activity but still lack to fully clarify the issue of oxidative stress and anaerobic physical activity. According to current knowledge, the oxidative modifications are similar to those caused by the oxidative stress during aerobic physical activity, but that is still to be thoroughly researched.

OXIDATIVE STRESS DURING PHYSICAL EXERCISE IN HEALTHY PERSONS

The reactive oxygen species play an important role as mediators of damage and inflammation of skeletal muscle after strenuous physical activities.

smanjenje bazalne produkcije oksidanata, i smanjeni gubitak radikala tokom oksidativne fosforilacije (Leeuwenburgh i Heinecke, 2001).

Povećana produkcija reaktivnih vrsta kiseonika i azota, kao i oksidativni stres, javljaju se i kod vrhunskih sportista usljed maksimalnih opterećenja bez obzira na tip energetskog zahtjeva samog sporta (aerobni, aerobnoanaerobni, anaerobni). Ispitivani su efekti dugogodišnjeg treniranja različitih tipova sportova: biciklizma, veslanja i tekvondoa na parametre oksidativnog stresa u stanju mirovanja, usled maksimalnog opterećenja (test progresivnog opterećenja) i u intervalu od četvrtog do desetog minuta oporavka. Rezultati studije pokazuju da treniranje različitih tipova sportova utiče na uspostavljanje različitih bazalnih nivoa nitrita i koncentracija tiobarbituratskih reaktivnih vrsta (TBARS) i to tako da je nivo nitrita najniži kod tekvondoa, zatim kod biciklizma, a najviši kod veslanja; dok je redoslijed nivoa TBARS-a: veslanje, tekvondo, biciklizam od najnižeg ka najvišem. Međutim, nije utvrđena značajna razlika u nivou parametara oksidativnog stresa tokom maksimalnog opterećenja, niti tokom desetominutnog perioda oporavka kod ispitivanih sportista, bez obzira na razlike u tipu sporta (Čubrilo i saradnici, 2011).

Iako se dobrobit od anaerobne fizičke aktivnosti ne može osporiti, postoji dovoljan broj naučnih dokaza da veoma visok intezitet anaerobne fizičke aktivnosti vodi ka pojavi oksidativnog stresa. Dugotrajna i intezivna anaerobna fizička aktivnost utiče na drastično povećanje produkcije reaktivnih vrsta kiseonika, tako da antioksidanti prisutni u tijelu nisu dovoljni, što vodi ka oksidativnom stresu i dalje izaziva mutacije u ćelijama, oštećenja tkiva i imunog sistema.

Anaerobna fizička aktivnost i oksidativni stres međusobno su povezani u smislu da intenzivna anaerobna fizička aktivnost vodi ka oštećenjima proteina, lipida i nukleinskih kiselina u mišićnim ćelijama i krvi. Postoje dokazi da stalna anaerobna fizička aktivnost povećava oksidativni stres u tijelu. Veliki broj istraživanja obiluje podacima o aerobnoj fizičkoj aktivnosti, ali još uvijek nisu u potpunosti razjašnjeni detalji o oksidativnom stresu i anaerobnoj fizičkoj aktivnosti. Prema dosadašnjim saznanjima, oksidativne modifikacije slične su onima koje su uzrokovane okisidativnim stresom usljed aerobne fizičke aktivnosti, ali to mora još istraživati.

OKSIDATIVNI STRES PRI FIZIČKOJ AKTIVNOSTI KOD ZDRAVIH OSOBA

Reaktivne vrste kiseonika imaju važnu ulogu kao medijatori oštećenja i zapaljenja skeletnih mišića nakon naporne fizičke aktivnosti. Velika količina ovih jedinjenja

Large amount of these compounds is formed from the increased oxygen consumption in mitochondria and increased electron transport flux (Sacheck & Blumberg, 2001). The reactive oxygen species (ROS) have a double effect on the contractile ability of rested skeletal muscles. The low level of reactive oxygen species in basic conditions is necessary for normal production of muscle force. The selective consumption of ROS in an unfatigued muscle by means of superoxide dismutase or catalase causes decline of force. As opposed to that, the mean values of ROS induce the increase of force. This positive effect has been confirmed at higher concentrations of ROS; the production of force recedes depending on the time and quantity. During strenuous physical activity these compounds contribute to the occurrence of acute muscle fatigue. ROS occur in muscles faster than they can be amortized by endogenous antioxidants. As ROS get accumulated in a muscle that performs labor, the production of force gets inhibited in it. Other factors that can increase activity of ROS include aging, muscle injuries and some diseases (Radovanović & Ranković, 2004).

Oxidative stress during physical activity in untrained persons

Many studies have examined the difference among genders in terms of the oxidative stress during exercise and the influence of antioxidant supplements (vitamins E and C). The results show that women at rest have higher level of antioxidants when compared to men. The markers of oxidative stress (protein carbonyl, oxidized and reduced glutathione, malondialdehyde, vitamins C and E in plasma) as the response on physical activity of similar scale and intensity almost grow equally at both genders (Goldfarb, McKenzie, & Bloomer, 2007).

The study that examined the influence of physical activity and food supplementation with carnitine onto the oxidative stress arising as the response on aerobic and anaerobic power test recorded the following results: MDA was under a minimal influence of physical activity but had lower values at rest among groups of respondents who undergone carnitine diet supplementation, whereas the values of hydrogen peroxide and xanthine oxidase higher after the physical activities in all groups. The physical activity accompanied by carnitine supplementation may have influence on the MDA level decrease at rest. However, the influence on biomarkers of the oxidative stress is relatively small (Bloomer & Smith, 2009).

The use of dietary antioxidants, such as vitamin E, in order to reduce the oxidative damage on muscles, has mixed success. The difference in the obtained

nastaje iz povećane potrošnje kiseonika u mitohondrijama i povećanog elektron-transportnog fluksa (Sacheck i Blumberg, 2001). Reaktivne vrste kiseonika (RVK) imaju dvostruko dejstvo na kontraktilnu sposobnost odmornih skeletnih mišića. Nizak nivo reaktivnih vrsta kiseonika u bazičnim uslovima neophodan je za normalnu produkciju sile. Selektivno trošenje RVK-a u nezamorenom mišiću pomoću superoksid-dismutaze ili katalaze uzrokuje opadanje sile. Nasuprot tome, srednje vrijednosti RVK-a izazivaju povećanje sile. Ovaj pozitivan efekat potvrđen je kod viših koncetracija RVK-a; produkcija sile opada u zavisnosti od vremena i količine. Tokom naporne fizičke aktivnosti ova jedinjenja doprinose razvoju akutnog mišićnog zamora. RVK nastaju u mišićima brže nego što mogu biti "amortizovani" endogenim antioksidantima. Kako se RVK akumuliraju u mišiću koji vrši rad, tako se u njemu inhibira produkcija sile. Drugi faktori koji takođe mogu povećati aktivnost RVK-a u mišićima su starenje, mišićne povrede i neka oboljenja (Radovanović i Ranković, 2004).

Oksidativni stres pri fizičkoj aktivnosti kod netreniranih osoba

Proučavane su razlike među polovima u oksidativnom stresu pri fizičkoj aktivnosti i uticaji antioksidantnih suplemenata (vitamini E i C). Rezultati pokazuju da žene imaju viši nivo antioksidanata u mirovanju u odnosu na muškarce. Markeri oksidativnog stresa (proteinski karbonili, oksidovani i redukovani glutation, malondialdehid, vitamini C i E u plazmi) kao odgovor na fizičku aktivnost sličnog obima i intenziteta gotovo jednako rastu kod oba pola. Dokazano je da antioksidantna suplemenatacija može umanjiti oksidativni stres uzrokovan fizičkom aktivnošću jednako kod oba pola (Goldfarb, McKenzie i Bloomer, 2007).

Studija koja je proučavala uticaj fizičke aktivnosti i suplementacije karnitinom na oksidativni stres, nastao kao odgovor na aerobni i anaerobni test snage, pokazala je sljedeće rezultate: MDA je pod minimalnim uticajem fizičke aktivnosti, ali pokazuje niže vrijednosti pri mirovanju kod grupa koje su koristile suplementaciju karnitinom, dok su vrijednosti hidrogen peroksida i ksantin oksidaze veće nakon fizičke aktivnosti u svim grupama. Fizička aktivnost, zajedno sa suplementacijom karnitinom, može uticati na smanjenje nivo MDA u mirovanju, ali je uticaj na biomarkere oksidativnog stresa sasvim mali (Bloomer i Smith, 2009).

Upotreba dijetetskih antioksidanata, kao što je vitamin E, kako bi se smanjila oksidativna oštećenja mišića usljed fizičke aktivnosti, ima mješovit uspeh. Razlike koje postoje u rezultatima javljaju se zbog

results is due to the testing of different antioxidants, the nature and extent of physical activity, age and physical condition of the respondents, as well as the applied methodology for the study of oxidative stress (Sacheck & Blumberg, 2001).

A high-calorie diet causes the oxidative stress while acute physical activity can potentially reduce stress. The influence of physical activity on triglycerides and glucose in obese Caucasian women was the subject of the following study. Lipemia and oxidative stress after meals are lower in obese black women when compare to obese white women, while the acute physical activity before a high-calorie diet did not generate any changes in the state of organism after meals in both groups (Bloomer, Cole, & Fisher Wellman, 2009).

The gender and the status of physical fitness may influence the oxidative stress after meals. All the analyzed biomarkers of oxidative stress (malondialdehyde, hydrogen peroxide, activity of xanthine oxidase, protein carbonyl and triglycerides) showed lower values in trained persons except for the TEAC (trolox equivalent antioxidant capacity), which further indicates that gender, and not the status of physical fitness, influence on the oxidative stress after meals. Women are also recorded to have a significantly lower level of oxidative stress biomarkers after meals when compared to men (Bloomer, Ferebee, Fisher Wellman, Quindry, & Schilling, 2009).

Older organisms are more susceptible to the oxidative stress during exercise due to the biochemical changes taking place with aging thus contributing to the formation of reactive oxygen species. The old age is also known to be prone to increased muscle injuries, and the inflammatory response of "the old"muscle may lead to the extended oxidative stress (Ji, 2001).

Oxidative stress during physical activity in trained persons

The production of ROS is linked to the muscle activity and depends on genes. In this regard, there is considerable interest in the possibility of these mediators to be part of muscle adaptation on the physical activity. Muscles adapt to physical activity by increasing gene expression in the regulation of antioxidant enzymes including superoxide dismutase, catalase and glutathione peroxidase (Radovanović & Ranković, 2004).

The parameters of oxidative stress are gender--determined in athletes, which accounted for the examination or relation between iron transport proteins (serum ferritin and transferrin, soluble transferrin receptor) and C-reactive proteins as proteins of

testiranja različitih antioksidanata, prirode i obima primijenjene fizičke aktivnosti, godina starosti i kondicije ispitivanih subjekata, kao i primijenjene metodologije za proučavanje oksidativnog stresa (Sacheck i Blumberg, 2001).

Visokokalorična ishrana uzrokuje oksidativni stres, dok akutna fizička aktivnost ima potencijal da ga smanji. Proučavan je uticaj akutne fizičke aktivnosti na triglicerid i glukozu kod gojaznih žena različitih rasa. Lipemija i oksidativni stres nakon obroka niži su kod žena crne rase u odnosu na gojazne žene bijele rase, dok akutna fizička aktivnost prije visokokaloričnog obroka nije izazvala promjene u stanju organizma nakon obroka u obje rasne grupacije (Bloomer, Cole i Fisher Wellman, 2009).

Pol i status treniranosti mogu uticati na oksidativni stres nakon obroka. Svi analizirani biomerkeri oksidativnog stresa (malondiadehid, hidrogen peroksid, aktivnost ksantin oksidaze, proteinski karbonili i trigliceridi) pokazali su niže vrijednosti kod treniranih subjekata osim TEAC-a (troloks-ekvivalentni antioksidantni kapacitet) što dalje ukazuje da pol, a ne status treniranosti, utiče na oksidativni stres nakon obroka. Specifično je još i to da žene imaju značajno niži nivo biomarkera oksidativnog stresa poslije obroka u odnosu na muškarce (Bloomer, Ferebee, Fisher Wellman, Quindry i Schilling, 2009).

Stariji organizmi su osetljiviji na oksidativni stres tokom fizičke aktivnosti usljed strukturalnih i biohemijskih promena koje nastaju sa starenjem i time olakšavaju nastajanje reaktivnih vrsta kiseonika. U starosti je takođe povećana i mogućnost mišićnih povreda, i inflamatorni odgovor "starog" mišića može voditi daljem oksidativnom stresu. Stoga, naporna fizička aktivnost nije preporučljiva starim osobama (Ji, 2001).

Oksidativni stres pri fizičkoj aktivnosti treniranih osoba

Produkcija RVK-a povezana je sa mišićnom aktivnošću i pod uticajem je gena. U vezi sa tim, postoji značajno interesovanje za mogućnosti ovih medijatora u regulaciji mišićne adaptacije na fizičku aktivnost. Mišići se adaptiraju na fizičku aktivnost tako što se povećava ekspresija gena u regulaciji antioksidantnih enzima, uključujući tu superoksid-dismutazu, katalazu i glutation peroksidazu (Radovanović i Ranković, 2004).

Parametri oksidativnog stresa su polno determinisani kod sportista, stoga je ispitivana povezanost proteina koji regulišu transport i deponovanje gvožđa u organizmu (serum feritin, transferin, receptor rastvorljivog transferina) i C-reaktivnih proteina kao proteina akutnofazne reakcije sa oksidativnim stresom. U studiji

acute-phased reaction with oxidative stress. Some 73 sportswomen and 65 sportsmen took part in the following study. The results showed that transferrin and ferritin as well as the proteins of acute-phased reaction were negatively related to the oxidative stress. The authors concluded that the variations in the level of ferritin may have contributed to a different level of the oxidative stress among sportsmen and sportswomen. The largest share in the variability of all parameters of the oxidative stress (46.3%) was attributed to the gender difference. The sportswomen were thus showed to be more susceptible to the oxidative stress (Dopsaj, Martinović, Dopsaj, Stevuljević, & Bogavac Stanojević, 2011).

An athlete's diet is often accompanied with antioxidant supplements in order to offset the oxidative stress occurring at physical strain. Research results still provide insufficient evidence on the reduction of the oxidative stress if such dietary supplementation is to be applied, though an increase in the oxidative capacity has been established (Urso & Clarkson, 2003).

The antioxidant supplementation (vitamins C and E, and selenium) combined with an eccentric exercise with additional burden (of the flexor in the elbow joint) in young trained showed that: applied program of physical activity influenced the reduce the amount of biomarkers in oxidative stress (protein carbonyl in plasma, malondialdehyde, oxidized and reduced glutathione); the antioxidant supplements affected the reduced increase of malondialdehyde and protein carbonyls (Goldfarb, Bloomer, & McKenzie, 2005).

The effect of two different forms of antioxidant supplementation (vitamins E and C in one case and fruit and vegetable juice concentrate in the other) on the oxidative stress during aerobic exercise in trained men and women was the subject in Bloomer, Falvo, Fry, Schilling and Smith's (2009) study. The results of the study indicated that both types of supplementation, administered in the course of two weeks, affect the reduced increase of protein carbonyls after the aerobic physical activity lasting for 30 minutes, whereas they had no effect on changes in MDA and 8-OhdG (Bloomer, Goldfarb, & McKenzie, 2006).

The influence of antioxidant supplementation in top female volleyball players in the course of six--week training period in preseason was the subject of the following study. The twenty-eight respondents were divided into two groups: experimental (n = 16), in which the volleyball players took the antioxidant cocktail (vitamin E, vitamin C, zinc gluconate and selenium), and control group (n = 12) in which supplementation was not administered. The blood samples were taken before and after the six-week training period. The following were put on the analysis:

je učestvovalo 73 sportistkinja i 65 sportista. Rezultati pokazuju da su transferin i feritin, kao i proteini akutnofazne reakcije negativno povezani sa oksidativnim stresom. Autori zaključuju da varijacije u nivou feritina mogu doprinijeti različitom nivou oksidativnog stresa kod sportista i sportistkinja. Najveći udio u promjenljivosti svih parametara oksidativnog stresa (46,3%) pokazala je polna pripadnost. Žene sportisti osetljivije su na oksidativni stres (Dopsaj, Martinović, Dopsaj, Stevuljević, i Bogavac Stanojević, 2011).

U ishrani sportista često se koriste antioksidantni suplementi kako bi djelovali nasuprot povećanom oksidativnom stresu koji se javlja pri fizičkim naporima. Još uvek nije u potpunosti poznato da li ova vrsta suplementacije zaista utiče na smanjenje oksidativnog stresa kod sportista, mada je dokazano da se na taj način povećava antioksidantni kapacitet (Urso i Clarkson, 2003).

Antioksidantna suplementacija (vitamini C i E i selen) u kombinaciji sa ekscentričnom fizičkom aktivnošću, uz dodatno opterećenje (fleksora u zglobu lakta), kod mladih treniranih žena pokazala je da: primijenjeni program fizičke aktivnosti utiče na smanjenje količine biomarkera oksidativnog stresa (proteinskih karbonila u plazmi, malondialdehida, oksidovanog i redukovanog glutation), kao i da antioksidantni suplementi utiču na smanjeni porast malondialdehida i proteinskih karbonila (Goldfarb, Bloomer i McKenzie, 2005).

Uticaj dvije različite forme antioksidantne suplementacije (vitaminima E i C u jednoj i koncentrovanim voćno-povrtnim sokom) na oksidativni stres pri aerobnoj fizičkoj aktivnosti treniranih muškaraca i žena ispitan je u studiji Bloomera, Falva, Frya, Schillinga i Smitha (2009). Dobijeni podaci ukazuju da obje vrste suplementacije, primjenjivane dvije sedmice, utiču na umanjeni porast proteinskih karbonila posle tridesetominutne aerobne fizičke aktivnosti, dok nemaju uticaja na promjene u MDA i 8-OhdG (Bloomer, Goldfarb i McKenzie, 2006).

Ispitivan je uticaj antioksidantne suplementacije kod elitnih odbojkašica tokom šestonedjeljnog perioda teniranja u predtakmičarskoj sezoni. U studiji je učestvovalo 28 subjekata podijeljenih u dvije grupe: eksperimentalnu (n = 16) u kojoj su odbojkašice uzimale antioksidantni koktel (vitamin E, vitamin C, cink-glutanot i selen) tokom posmatranog perioda, i kontrolnu (n = 12) u kojoj nije primjenjivana suplementacija. Uzorci krvi uzimani su na početku i na kraju šestonedjeljnog perioda treniranja i analizirani su nivoi reaktivnih kiseoničnih metabolita (ROM) kao zavisne varijable

levels of reactive oxygen metabolites (ROM) as dependent variables and malondialdehyde; superoxide anion radical, "advanced" products of protein oxidation and lipid hydroperoxide as independent variables. The correlation between the levels of reactive oxygen metabolites and other parameters of the oxidative stress was reduced in the experimental group and it was also observed that the application of antioxidant supplementation in the preseason prevents antioxidant defense depletion (Martinović et al., 2011), which was found to be important bearing in mind that female athletes were established to be more susceptible to the oxidative stress (Dopsaj et al., 2011).

Radovanovića et al. (2008) examined the change in certain biomarkers of the oxidative stress during Tae Bo (7 female respondents, 12 weeks of training sessions) and Pilates training sessions (7 female respondents, 12 weeks of training sessions). The blood samples were taken at rest both at the beginning and in the end of the appropriate training period, and they were analyzed in order to establish the markers of the oxidative stress (malondialdehyde, catalase in plasma, carbonyl and sulfhydryl groups, total antioxidant status). Statistically significant increase of the total antioxidant status after Tae Bo training session as well as the activity of catalase in plasma after Pilates training program were the most important findings of this research. Due to different metabolic demands during these two types of training sessions, the conclusion was that the increased oxygen consumption was not sole mechanism causing the oxidative stress during exercise.

The health consequences of increased oxidative stress during training or performing a highly strenuous sport have not been totally elucidated though it is a well-known fact that such a physical activity is related to the improvement of endogenous antioxidant defense. A research conducted on well-trained men practicing and competing in triathlon showed that the level of all analyzed biomarkers of oxidative stress returned to the initial level (the level before competition) five days after the race, and that there was a correlation between the state of being well-trained, markers of the oxidative stress and the activity of antioxidant enzymes. To conclude, the alternatives of the antioxidant defense system in this population prevent the occurrence of long-term oxidative stress during intensive physical strain (Neubauer, König, Kern, Nics, & Wagner, 2008).

The research examining changes in parameters of anaerobic and aerobic capacities alongside with the biomarkers of oxidative stress among eight selected judoists during 12-week long training program in preseason showed that the increase in parameters of anaerobic capacity was accompanied by the increase

i malondialdehid, superoksid anjonski radikal, "napredni" produkti oksidacije proteina i lipid hidroperoksid kao nezavisne varijable. Povezanost između nivoa reaktivnih kiseoničnih metabolita i ostalih parametara oksidativnog stresa smanjena je kod eksperimentalne grupe odbojkašica, a pokazalo se i da primijenjeni tretman antioksidantne suplementacije u predtakmičarskoj fazi sprečava iscrpljivanje antioksidantne odbrane (Martinović i saradnici, 2011), što je veoma važno s obzirom da je utvrđeno da su žene sportisti podložnije oksidativnom stresu (Dopsaj i saradnici, 2011).

U studiji Radovanovića i saradnika (2008) praćena je promjena određenih biomarkera oksidativnog stresa tokom tea-bo treninga (7 ispitanica ženskog pola, 12 nedjelja treninga) i pilates treninga (7 ispitanica ženskog pola, 12 nedjelja treninga). Uzorci krvi uzimani su u mirovanju, na početku i na kraju odgovarajućeg perioda treninga, i analizirani u cilju određivanja markera oksidativnog stresa (malondialdehida, katalaze u plazmi, karbonilnih i sulfhidrilnih grupa, ukupnog antioksidativnog statusa). Statistički značajna povećanja ukupnog antioksidativnog statusa nakon tae-bo trening programa, kao i aktivnosti katlaze u plazmi nakon pilates trening programa najznačajniji su nalazi ovog istraživanja. Zbog različitih metaboličkih zahtjeva tokom ove dvije vrste treninga, zaključeno je da povećana potrošnja kiseonika nije jedini mehanizam koji uzrokuje oksidativni stres tokom fizičke aktivnosti.

Zdravstvene posljedice povećanog oksidativnog stresa koji nastaje pri treniranju i takmičenju u izuzetno napornim sportovima nisu potpuno razjašnjene, mada se zna da je takva fizička aktivnost povezana sa poboljšanjem endogene antioksidantne odbrane. U tom smislu, izvedeno istraživanje na dobro treniranim muškarcima koji treniraju i takmiče se u triatlonu pokazalo je da se nivo svih analiziranih biomarkera oksidativnog stresa vraćaju na početni nivo (nivo prije takmičenja) pet dana nakon trke, kao i da postoji povezanost između stanja treniranosti, markera oksidativnog stresa i aktivnosti antioksidantnih enzima. Dakle, alternative antioksidantnog sistema odbrane kod ovako trenirane populacije sprečavaju pojavu dugoročnog oksidativnog stresa nakon intezivnog naprezanja (Neubauer, König, Kern, Nics i Wagner, 2008).

U istraživanju promjena parametara anaerobnog i aerobnog kapaciteta, kao i biomarkera oksidativnog stresa kod 8 selekcionisanih džudista tokom 12-nedjeljnog trenažnog programa pripremnog perioda, rezultati su pokazali da je povećanje parametara anaerobnog kapaciteta bilo praćeno poremećajem ravnoteže između

balance disorder between reactive oxygen species and the overall antioxidant system in the organism, statistically significant increase in the values of malondialdehyde in erythrocytes and catalase in plasma (Radovanović, Bratić, Nurkić, Kafentarakis, & Kolias, 2008).

The study of Radovanović, Bratić, and Nurkić (2008) dealt with the oxidative stress markers in young judoist during four weeks preparation period training program which included: strength training, training techniques and judo fights (randors). Ten young judoists were part of this study. The blood samples were taken at rest before and after four weeks preparation period training program, and the analysis included changes in oxidative stress markers (MDA, CAT, carbonyl and sulfhydryl groups and total antioxidant status). The obtained results indicated that such a training program did not bear any statistically significant effects on the parameters of oxidative stress in well-trained young judoists, so the conclusion was that oxidative defense in the organism was sufficient in dealing with the oxidative stress.

During twelve weeks comparative strength-endurance training program, the authors monitored the change of oxidative stress parameters in 14 judoists divided into the experimental and control group. Besides, the effects of such a training program were compared to the normal training program effects in terms of maximal oxygen consumption, parameters of anaerobic capacity, situational-motor abilities and body composition. The obtained results showed that the comparative strength-endurance training led to an increase in maximal oxygen consumption and anaerobic capacity, but also caused the balance disorder between reactive oxygen species and antioxidant system of the entire body. This study also considered the possibility that pro-oxidants represented a stimulus for the increase of antioxidant defense aiming to achieve maximum adaptation on such a type of training (Radovanović et al., 2009).

The length of sports experience also has an effect on occurrence, level and possibility of adaptation on the oxidative stress. The study of Martinovic et al. measured the parameters of oxidative stress in 54 top female volleyball players, which were divided in three groups depending on the length of their sports experience: 1st group – under 8 years of experience, 2nd group - from 8 to 10.5 years of experience, 3rd group – over 10.5 years of experience; all in order to examine the influence of years long training on the oxidative stress. As the most reliable indicators the following were singled out: activity of superoxide dismutase (SOD) – statistically significant higher values in group 3 as opposed to group, and the level of superoxide anion – statistically significant lower values in group 3 as opposed to group 1. The status of parameters of oxidative stress pointed to a high

reaktivnih vrsta kiseonika i antioksidativnog sistema u organizmu, statistički značajnim povećanjem vrijednosti malondialdehida u eritrocitima i katalaze u plazmi (Radovanović, Bratić, Nurkić, Kafentarakis i Kolias, 2008).

U drugoj studiji Radovanović, Bratić i Nurkić (2008) bavili su se određivanjem nekih markera oksidativnog stresa kod mladih džudista tokom 4-nedjeljnog programa treninga u pripremnom periodu koji je uključivao: trening snage, trening tehnike i džudo borbe (randori). U studiji je učestvovalo 10 mladih džudista. Uzorci krvi uzimani su u mirovanju prije i nakon 4-nedjeljnog programa treninga i analizirane su promjene markera oksidativnog stresa (MDA, CAT, karbonil i sulfhidril grupe i ukupni antioksidantni status). Dobijeni rezultati ukazuju da ova vrsta programa treninga u pripremnom periodu nema statistički značajnih efekata na parametre oksidativnog stresa kod dobro utreniranih mladih džudista, pa je zaključeno da antioksidantna odbrana u organizmu sasvim dovoljna da se izbori sa nastalim oksidativnim stresom.

Tokom 12-nedjeljnog uporednog treninga snage i izdržljivosti praćena je promjena parametara oksidativnog stresa kod 14 džudista podijeljenih na eksperimentalnu i kontrolnu grupu. Osim toga, upoređivani su efekti ovakvog treninga sa uobičajenim trening programom džudista na maksimalnu potrošnju kiseonika, parametre anaerobnog kapaciteta, situaciono-motoričke sposobnosti i tjelesni sastav. Dobijeni rezultati pokazali su da uporedni trening snage i izdržljivosti dovodi do povećanja maksimalne potrošnje kiseonika i anaerobnog kapaciteta, ali uzrokuje poremećaj ravnoteže između reaktivnih vrsta kiseonika i antioksidativnog sistema u organizmu. U ovoj studiji razmatrana je još i mogućnost da stvaranje prooksidanata predstavlja stimulus za povećanje antioksidativne odbrane u cilju postizanja maksimalne adaptacije na ovakvu vrstu treninga (Radovanović i saradnici, 2009).

Dužina sportskog staža takođe utiče na pojavu, nivo i mogućnost adaptacije na oksidativni stres. Parametri oksidativnog stresa mjereni su kod 54 elitne odbojkašice, podijeljene u tri grupe u zavisnosti od dužine sportskog staža: 1. grupa - manje od 8 godina, 2. grupa - od 8 do 10,5 godina, 3. grupa - više od 10,5 godina, kako bi se ispitao uticaj dugogodišnjeg treniranja na oksidativni stres. Kao najbolji pokazatelji razlike među posmatranim grupama izdvojili su se: aktivnost superosid-dismutaze (SOD) - statistički značajno više vrijednosti kod 3. grupe u odnosu na 1. grupu, i nivo superoksid anjona - statistički značajno niže vrijednosti kod 3. grupe u odnosu na 1. grupu. Dakle, status

percentage (68.5%) in terms of the existence of differences in occurrence and adaptation onto the oxidative stress in top female volleyball players with different length of sports experience (Martinović et al., 2009).

There are still few available data concerning the system of antioxidant defense and its response to exercise in adolescents and young athletes. The effect of years long training of handball on the redox status of adolescent players (from 16 to 19 years of age) as well as the correlation between the homeostasis redox and aerobic power was examined in the study of Đorđević et al. (2011). The collected blood samples included 33 young handball players and 14 non-athletes of the same age who underwent the test of maximum progressive load in order to establish their Vo_2max. The handball players showed a much higher activity of superoxide dismutase and much lower activity of catalase; the most evident results were present in those who had low or average aerobic power. The aerobic power and years long regular exercise proved themselves to have important influence in redox status improvement in the youth and adolescents, which provides for the better adaptation on the oxidative stress (Ibid).

The application of similar anaerobic physical activities (squats and sprints) at anaerobically trained persons resulted in minor differences in the level of oxidative stress and muscle tissue injuries. Physiological responses in that case were probably reduced due to the adaptation of organism on regular and strenuous anaerobic (Bloomer, Falvo, Fry, Schilling, & Smith, 2006a).

The study of Đorđević et al. (2010) examined the interaction between nitrogen oxide and anion radicals during the increasing load in 19 top-class footballers. The analysis of blood samples collected during the last 10 seconds of each phase of the maximal progressive load test indicated that the regression lines of nitrites and superoxide anion radicals surpass the level of anaerobic threshold, which may have hinted that the very anaerobic threshold could have been of the utmost importance in both anaerobic and aerobic metabolism. The long-time physical activity proved to have an increasing effect in terms of bioavailability of nitrogen oxide and have positive correlation compare to the maximal oxygen consumption.

OXIDATIVE STRESS DURING PHYSICAL ACTIVITY IN PERSONS WITH IMPAIRED HEALTH STATUS

Oxidative stress and disbalance between the production of reactive oxygen species and capacity of antioxidant defense of an organism is closely linked with the age and different illnesses such as: cardiovascular and respiratory diseases and diabetes.

parametara oksidativnog stresa ukazuje sa visokim udjelom (68,5%) na postojanje razlika u pojavi i adaptaciji na oksidativni stres kod elitnih odbojkašica sa različitom dužinom sportskog staža (Martinović i saradnici, 2009).

Još uvijek je malo dostupnih podataka o adaptaciji sistema antioksidantne odbrane usljed fizičkih aktivnosti kod adolescenata i mladih sportista. Ispitan je efekat dugogodišnjeg treniranja rukometa na redoks status sportista adolescenata (16 do 19 godina starosti) i korelacija između redoks homeostaze i aerobne moći. Prikupljeni su uzorci krvi 33 mlada rukometaša i 14 nesportista iste dobi koji su izveli test maksimalnog progresivnog opterećenja kako bi im bila određena i VO_2max. Sportisti su pokazali znatno veću aktivnost superoksid-dismutaze i znatno nižu aktivnost katalaze u odnosu na nesportiste, i to najizraženije kod subjekata koji imaju nisku ili prosječnu aerobnu moć. Aerobna moć i dugogodišnja fizička aktivnost izuzetno su važni za poboljšanje redoks statusa mladih i adolescenata, što im omogućava bolju adaptaciju na oksidativni stres (Đorđević i saradnici, 2011).

Primjenom sličnih anaerobnih fizičkih aktivnosti (čučnjeva i sprinta) kod anaerobno utreniranih subjekata javljaju se neznatne razlike u nivou oksidativnog stresa i povredama mišićnog tkiva. Fiziološki odgovori u tom slučaju vjerovatno su smanjeni zbog adaptacije organizma na redovan, naporan anaerobni trening (Bloomer, Falvo, Fry, Schilling, i Smith, 2006).

U studiji Đorđević i saradnici (2010) istraživano je sadejstvo između azot-oksida i superoksid anjonskog radikala tokom rastućeg opterećenja kod 19 elitnih fudbalera. Analiza uzoraka krvi prikupljenih tokom posljednjih 10 sekundi svake faze maksimalnog progresivnog testa opterećenja pokazuje da regresione prave nitrita i superoksid anjonskog radikala prelaze nivo anaerobnog praga, što pokazuje da bi upravo anaerobni prag mogao biti od krucijalne važnosti ne samo u anaerobnom, već i u aerobnom metabolizmu. Dugogodišnja fizička aktivnost, pokazalo se, povećava bioraspoloživost azot-oksida i ima pozitivnu korelaciju sa maksimalnom potrošnjom kiseonika.

OKSIDATIVNI STRES PRI FIZIČKOJ AKTIVNOSTI KOD LJUDI NARUŠENOG ZDRAVSTVENOG STATUSA

Oksidativni stres i disbalans između proizvodnje reaktivnih vrsta kiseonika i kapaciteta antioksidantne odbrane organizma usko je povezan sa godinama starosti, kao i brojnim bolestima kao što su:

Persons with disturbed metabolism of lipids and glucose have an increased risk of oxidative stress after meal. The effects of acute physical activity on the level of triglycerides and biomarkers of the oxidative stress have been examined in prediabetic women, who exercised 15 minutes after meal. The results showed that this type of physical activity did not have any influence on the level of triglycerides and the occurrence of oxidative stress, so it could be assumed that a more intensive exercising was to be called for if measurable effects were to be come at (Melton, Tucker, Fisher Wellman, Schilling, & Bloomer, 2009).

Atalay and Laaksonen (2002) collected many data on the interdependent mechanisms, which increase the production of reactive oxygen and nitrogen species and reduce the antioxidant defense in diabetics. The modern medicine considers the regular exercising to be of great importance in treatment of diabetes. Although acute exhausting exercise increases the oxidative stress, the study showed that regular physical activity regulates the antioxidant defense. Should regular exercise prove to have any protective effects against the oxidative stress in diabetics, which would have a direct impact on the use of physical activity as a safe therapeutic modality in the treatment of diabetes.

Programmed physical activity is one of the key elements in accomplishment of sound glycemic control and attenuation of possible cardiovascular diseases resulting from diabetes type 2. The leading clinical findings emphasize the therapeutic benefit of exercising, so patients with such diseases should be stimulated to participate in specially designed intervention programs (Praet & van Loon, 2009).

CONCLUSION

The discovery of the so-called oxidative paradox inspired the researches to intensify their efforts in the realm of oxidative stress, antioxidant defense and the influence of physical activity on these phenomena. Nearly all studies from the last decade dealing with the oxidative stress and physical activity analyzed MDA, 8-ONdG and protein carbonyls as biomarkers of change occurring in an organism. Most of the studies confirmed the changes in biomarkers indicating lipid peroxidation and modifications on proteins. Untrained persons, as opposed to the trained ones, are more susceptible to major changes in the body caused by oxidative stress during physical activity. The results of researches have showed that there are no significant differences between the genders in the level of oxidative stress during physical activity and the response of the body on the application of anti-

kardiovaskularna i respiratorna oboljenja, dijabetes.

Osobe sa poremećenim metabolizmom lipida i glukoze imaju povećan rizik od oksidativnog stresa nakon obroka. Istraženi su efekti akutne fizičke aktivnosti na nivo triglicerida i biomarkera oksidativnog stresa u krvi kod predijabetičnih žena koje su vježbale 15 minuta nakon obroka. Rezultati pokazuju da ova vrsta fizičke aktivnosti nema uticaja na nivo triglicerida i pojavu oksidativnog stresa nakon obroka kod gojaznih žena koje su sklone dijabetesu, pa se može pretpostaviti da je potrebno primijeniti intenzivniju fizičku aktivnost kako bi bili postignuti mjerljivi efekti (Melton, Tucker, Fisher Wellman, Schilling i Bloomer, 2009).

Prikupljeni su podaci o mnogim međuzavisnim mehanizmima koji povećavaju proizvodnju reaktivnih vrsta kiseonika i azota i smanjuju antioksidantnu odbranu kod dijabetičara. U modernoj medicini se smatra da je redovna fizička aktivnost izuzetno važna u tretmanu dijabetesa. Iako akutno iscrpljujuće vježbanje povećava oksidativni stres, pokazano je da redovna fizička aktivnost reguliše antioksidativnu odbranu. Ukoliko se pokaže da redovna fizička aktivnost može imati zaštitne efekte protiv oksidativnog stresa kod dijabetičara, to bi imalo direktan uticaj na upotrebu fizičke aktivnosti kao bezbjednog terapeutskog modaliteta kod dijabetesa (Atalay i Laaksonen, 2002).

Dokazano je da programirana fizička aktivnost predstavlja jedan od važnih elemenata u postizanju dobre glikemijske kontrole i smanjenja mogućih kardiovaskularnih oboljenja kod dijabetesa tipa 2. Vodeća klinička saznanja ističu terapeutsku vrijednost fizičke aktivnosti, pa bi pacijente sa ovim oboljenjem trebalo stimulisati da učestvuju u specijalno dizajniranim interventnim programima (Praet i van Loon, 2009).

ZAKLJUČAK

Sa otkrićem tzv. oksidativnog paradoksa, istraživači su počeli intezivno da se bave problemom oksidativnog stresa, antioksidantne odbrane i uticajem fizičke aktivnosti na ove pojave. U gotovo svim studijama tokom posljednje dekade koje se bave oksidativnim stresom i fizičkom aktivnošću analizirani su MDA, 8-ONdG i proteinski karbonili kao biomarkeri promjena koje se dešavaju u organizmu. Većina potvrđuje promjene u biomarkerima koji ukazuju na lipidnu peroksidaciju i modifikacije na proteinima. Netrenirane osobe, za razliku od treniranih, podložnije su većim promjenama u organizmu, uzrokovanim oksidativnim stresom pri fizičkoj aktivnosti. Nema bitnih razlika među polovima po pitanju oksidativnog stresa pri fizičkoj aktivnosti i odgovoru organizma na eventualno primijenjenu antioksidantnu suplementaciju. Međutim,

oxidant supplementation; however, the latest findings reveal that female athletes are more susceptible to oxidative stress than male athletes. The proteins responsible for transport and deposition of iron (transferrin and ferritin) should be punt under a more detailed examination in the context of monitoring the occurrence and adaptation onto the oxidative stress. Practicing and training of different types of sports affects the establishment of different basal levels of nitrite and concentration of thiobarbituric reactive species (TBARS). The regression lines of nitrite and superoxide anion radicals surpass the anaerobic threshold at maximal progressive load testing, which indicates that the anaerobic threshold could be of great importance when discussing both anaerobic and aerobic metabolism.

The increased oxidative stress typically occurs after meal so the physical activity, taking place before or after meal, does barely nothing to affect that phenomenon, especially among people with impaired health status. It is noteworthy that despite numerous relevant studies, the exact place of oxidative stress occurrence remains unidentified, as well as the exact benefit of antioxidant supplementation as a response to oxidative stress. With an ever increasing number of the youth being exposed to strenuous trainings, it becomes necessary to devote attention to research dealing with antioxidant defense, redox status and antioxidant stress among this population.

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najnovija istraživanja pokazuju da su žene sportisti ipak podložnije oksidativnom stresu u odnosu na muškarce sportiste. Proteine odgovorne za transport i deponovanje gvožđa (transferin i feritin) trebalo bi detaljnije ispitati u kontekstu praćenja nastanka i adaptacije na oksidativni stres. Treniranje različitih tipova sportova utiče na uspostavljanje različitih bazalnih nivoa nitrita i koncentracija tiobarbituratskih reaktivnih vrsta (TBARS). Regresione prave nivoa nitrita i superoksid anjonskog radikala prelaze anaerobni prag kod ispitivanja maksimalnog progresivnog opterećenja sportista, što ukazuje na mogućnost da je upravo anaerobni prag od velike važnosti kako u anaerobnom, tako i u aerobnom metabolizmu.

Karakteristično je da se pojačani oksidativni stres javlja nakon obroka, a fizička aktivnost prije ili poslije obroka ne može mnogo na to uticati, posebno kod ljudi sa narušenim zdravstvenim statusom. Interesantno je da i pored brojnih studija, tačna lokacija nastanka oksidativnog stresa pri fizičkoj aktivnosti još uvijek nije utvrđena, kao ni kolika je stvarna korist od antioksidatne suplementacije u odbrani od oksidativnog stresa. Sve je više mladih uključeno u naporne treninge, tako da je njihov sportski staž dug već u adolescentsko doba, pa bi trebalo više pažnje posvetiti istraživanjima o antioksidantnoj odbrani, redoks statusu i oksidativnom stresu kod ove populacije.

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OXIDATIVER STRESS UND KOERPERLICHE AKTIVITAET

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Die Entstehung oxidativer Paradoxe inspirierte eine Gruppe von Wissenschaftlern die Frage zu stellen, ob zu grosse Zufuhr an Sauerstoff, waehrend der koerperlichen Aktivitaet, zu einem oxidativen Stress und zum Risiko bezueglich des biologischen Systems fuehren kann (Jenkins, 2000). Erste Anzeichen, dass freie Radikale, die als Folge der koerperlichen Aktivitaet entstanden, sich sogar auf die Beschaedigung des Gewebes auswirken koennten, meldeten sich noch 1978, so dass sich die Wissenschaftler mit diesem Problem die letzten drei Jahrzehnten auseinandersetzen. Die, auf die Art und Weise, freigewordenen Radikale sind nach ihrer Herkunft reaktive Sauerstoffspezies (ROS): Superoxid, Hydroxil, Alkoxil, Peroxil und Hydroperoxil, oder reaktive Stickstoffspezies (RNS): Stickstoffmonoxid, Stickstoffdioxid, oxidativer Peroxinitrit (Cooper, et al., 2002). Als Gegengewicht der Entstehung freier Radikale im Koerper existiert ein System des antioxidatives Schutzes, das in zwei Einheiten geteilt wird: enzymer Schutz, der aus der

Superoxid-Dismutase (SOD), Katalase (CAT), Paraoxanase und der Glutathion-Peroxidase (GPX) besteht; und nicht enzymer Schutz, unter dem man die Beteiligung der folgenden Supstanzen versteht: Vitamine C und E, Retinol, Bilirutin, Harnsaeure, reduziertes Glutathion, Tioli, Coenzym Q10, Stressprotein, Albumin, als auch Transportproteine und Deponieproteine Fe2+ und Cu2+ (Transferrin und Fernitin), die die gefaehrlichen Metallione an sich binden und ihnen die Beteiligung in der Produktion der freien Radikale nicht ermoeglicht. Die negativen Effekte der Aktivitaet der freien Radikale spiegelt sich ab an verschiedenen Biomolekuelen (Lypide, Proteine und DNA-Molekuele), und die Folge ihre Interaktion ist ein erhoehtes Nachgeben der Zellenmembrane, beschlaeunigter Abbaustoffwechsel der Proteine und genetische Mutationen (Martinović. 2009). Es gibt eine Vielzahl an Methoden die zur Bestimmung der Groesse des oxidativen Stresses geeignet sind.

Oxidativer Stress kann auf folgenden Wegen geprueft werden: durch das direkte Messen der freien Radikale, durch das Messen von oxidativer Beschaedigungen an den Lypiden (lypide Peroxidation-Malondialdehyd-MDA, F2-Izoprostan, ausgeatmeter Pentan, Hexan oder Ethan), Proteinen (Proteinmodifikationen – Menge von Karbonil, das Verhaeltnis Karbonil / Protein) und DNA-Molekuelen (Modifikationen an DNA-Molekuelen – Nukleotid 8 – Hidroxi – 2 – Deoxiguanozin (8-Ohd)), durch das Messen anderer indirekter Anzeiger von oxidativem Stress (Creatinkinase – CK und Mioglobin), durch das Messen der Antioxidanten (enzymen – SOD, CAT, GPX, nicht enzymen – antioxidanten Vitaminen A, C und E im Plasma, Tiolprotein, Harnsaeure, Alantoin) und durch das Messen der gesamten antioxidanter Kapazitaet (TAC – total antioxidant capacity). Koerperliche Aktivitaet kann ein Ungleichgewicht zwischen den reaktiven Sauerstoffspezies und den Antioxidanten im Koerper verursachen, was zum oxidativen Stress fuehren kann.

Es wird behauptet, dass koerperliche Aktivitaet zur Steigerung der reaktiven Sauerstoffspezies beitraegt, was zur Beschaedigung der Zellen fuehren kann. Stressproteine stellen einen der allgemeinen Schutzmechanismen dar, das der Zelle und dem ganzen Koerper ermoeglicht den Stress zu ueberleben. Der genaue Zusammenhang der koerperlichen Aktivitaet, der Stressproteine und der reaktiven Sauerstoffspezies ist noch immer unbekannt (Radovanović & Ranković, 2004).

Antioxidante Enzyme sind endogen und ihre Entstehung kann mit bestimmten Faktoren veraendert werden. Als bekannte Faktoren der erhoehten Produktion von enzymer Antioxidanten werden die koerperliche Aktivitaet und das Training betrachtet (Finaud, et al., 2006). Der erhoehte aerobe Stoffwechsel waehrend der koerperlichen Aktivitaet ist ein moeglicher Ausloeser des oxidativen Stresses. Obwohl die gesuendheitlichen Vorteile der regelmaessigen koerperlichen Aktivitaet bekannt sind, wurde die Moeglichkeit der Senkung des oxydativen Stresses auf Grund der Anpassung auf die koerperliche Aktivitaet geprueft. Unter dem versteht man die Erhoehung des antioxidativen Verteidigungsmechanismus, die Senkung der basalen Produktion an Oxidanten und kleineren Verlust von Radikalen waehren der oxidativen Phosphorylierung (Leeuwenburgh & Heinecke, 2001). Es wurde auch bewiesen, dass eine andauernde und intensive anaerobe koerperliche Aktivitaet, zur drastischer Produktion an reaktiver Sauerstoffspezies beitraegt, so dass die sich im Koerper befindenden Antioxidanten nicht ausreichen, was zum oxidativen Stress, weiteren Mutationen in den Zellen und Beschaedigungen des Gewebes, wie auch des Immunsystems fuehrt.

Nach dem derzeitigen Wissensstand, sind oxidative Modifikationen, die auf diese Art und Weise entstehen, vergleichbar mit dem oxidativen Stress der unter einer aeroben koerperlichen Aktivitaet entsteht. Reaktive Sauerstoffspezies haben einen Doppeleffekt auf die kontraktilen Faehigkeiten der ausgeruhten Skelettmuskeln. Ein niedriges Nivou an reaktiven Sauerstoffspezies in normalen Rahmenbedingungen ist notwendig fuer die normale Produktion der Kraft. Auf der anderen Seite, mittlere Werte an reaktiven Sauerstoffspezies dienen der Erhoehung der Muskelkraft.

Waehrend einer anstrengenden koerperlichen Aktivitaet fuehren diese Verbindungen zur akuten Muskelerschoepfung.

Radikale Sauerstoffspezies entstehen in den Muskeln schneller als sie von den endogenen Antioxidanten "amortisiert" werden koennen. Das heisst, wenn sich in den arbeitenden Muskeln die reaktiven Sauerstoffspezies anstauen, hemmen sie die Produktion der Kraft (Radovanović & Ranković, 2004).

Die Ergebnisse der Untersuchung zeigen dass: Frauen in der Ruhestellung ein hoeheres Nivou an Antioxidanten haben als die Maenner, als auch dass die antioxidante Supplementierung den durch die koerperliche Aktivitaet entstehenden oxidativen Stress bei Maennern und Frauen gleich verringern kann (Goldfarb, et al., 2007); die Benutzung der diaetetischen Antioxidanten, wie es das Vitamin E ist, im Sinne der Senkung oxidativer Muskelbeschaedigungen aufgrund der koerperlichen Aktivitaet, hat einen gemischten

Erfolg erbracht, und die unterschiedlichen Ergebnisse entstehen aufgrund verschiedener Tests von Antioxidanten, der Umgebung und des Volumens der koerperlichen Aktivitaet, des Altersunterschieds sowie der unterschiedlichen koerperlichen Vorbereitung der getesteten Subjekten, aber auch wegen der angewendeten Methodik zur Untersuchung des oxidativen Stresses (Sacheck & Blumberg, 2001); kaloriereiche Ernaehrung verursacht oxidativen Stress, wobei die akute koerperliche Aktivitaet die Faehigkeit besitzt ihn zu verringern (Bloomer, et al., 2009a); das Geschlecht und nicht das Trainingsnivou wirken sich auf den oxidativen Stress nach dem Essen aus (Bloomer, et al., 2009); aeltere Menschen sind sehr empfindlich auf den oxidativen Stress, der waehrend der koerperlichen Aktivitaet entsteht, was auf die strukturellen und biomechanischen Veraenderungen als Folge des Alterns zurueckzufuehren ist, und somit die Entstehung der reaktiven Sauerstoffspezies erleichtert (Ji, 2001); die Muskeln passen sich der koerperlichen Aktivitaet an indem sich der Ausdruck des Gens im Zusammenhang mit dem antioxidativen Enzym erhoeht, einschliesslich der Superoxid-Dismutase, Katalase und der Glutathion-Peroxidase (Radovanović & Ranković 2004); in der Ernaehrung eines Sportlers werden haeufig antioxidative Supplemente verwendet mit den man sich dem, durch die koerperliche Belastung, erhoehten oxidativen Stress widersetzt, wobei man sich noch immer nicht im Klaren ist ob sich diese Art der Supplementierung auf die erniedrigung des oxidativen Stresses bei einem Sportler auswirkt, obwohl schon bewiesen wurde dass auf diese Art und Weise man die antioxidative Kapazitaet erhoeht (Urso & Clarkson, 2003); oxidativer Stress und das Ungleichgewicht zwischen der Erstellung von reaktiver Sauerstoffspezies und der Kapazitaet der antioxidativen Verteidigung des Koerpers sing eng verbunden mit dem Alter und der Vielzahl an Erkrankungen der folgenden Art: Herz-Kreislauf-Erkrankungen und Erkrankungen der Atemwege, Diabetis. Es ist interessant, dass trotz vieler Studien, der genaue Ort der Entstehung von oxidativen Stress bei einer koerperlichen Belastung noch nicht definiert wurde, so auch wie der wirkliche Effekt von antioxidativer Supplementierung in der Bekaempfung von oxidativen Stress ist, was dazu fuehrt, dass die entscheidenden Fragen und Antworten noch immer offen stehen.

Schluesselwoerter: koerperliche Aktivitaet, oxidativer Stress, Antioxidanten.

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UTICAJ ZADATAKA SA OGRANIČENJIMA NA KRETANJE NAPADAČA U SEGMENTU IGRE 1 NA 1 U TRENINGU FUDBALERA

INFLUENCE OF TASK CONSTRAINTS ON ATTACKER TRAJECTORIES DURING 1V1 SUB-PHASES IN SOCCER PRACTICE

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SUMMARY

The task constraints are prevalent elements used by coaches to train their players in sports training (Araújo, 2006; Newel, 1986). The scope of this study focuses on the analysis of spatial occupation of the attacking player in the practice space, when subjected to certain instructional constraints, on 1v1 soccer sub-phase. This study analyzed 11 soccer players (17.91 ± 1.04 years old) with 8.60 ± 1.52 years of practice. The heat maps presented differences on the occupied field surface in the various practice conditions. The analysis of variance of the duration of the offensive attempt also presented statistical differences within the various practice conditions ($F_{(2, 327)} = 30.776$; $p = .01$). Results suggest that in risk situations the attacker tends to promote the space-time symmetry. On the other hand, when the instruction to keep the ball was given, unlike the risk constraint, there was a lateralization of the action, increasing the variability and dispersion of the attacker's trajectories. This study demonstrated the relevance of manipulating instructional constraints.

Key words: Task Constraints, instruction, soccer, spatial occupation, heat maps.

SAŽETAK

Vježbe koje najčešće koriste treneri u treningu sa svojim igračima su zadaci sa ograničenjima (Araújo, 2006; Newel, 1986). Tema ovog istraživanja je analiza korištenja prostora i kretanja napadača u treningu, kada su im dati određeni zadaci sa ograničenjima u napadačkoj akciji 1 na 1. Ovim istraživanjem je analizirano 11 fudbalera (17,91 ± 1,04 godina) sa igračkim iskustvom 8,60 ± 1,52 godine. Toplotne mape predstavljaju razlike u korištenoj površini terena u različitim uslovima treninga. Analiza varijanse trajanja napadačkog pokušaja takođe je predstavila statističke razlike u različitim uslovima treninga ($F_{(2, 27)} = 30,776$; $p = 0,01$). Rezultati pokazuju da se u rizičnim situacijama napadač opredjeljuje za prostorno-vremensku simetriju. S druge strane, kada dobije upustva da zadržati loptu, za razliku od rizik ograničenja, dolazilo je do lateralizacije akcija, povećanja varijabilnosti i disperzije kretanja napadača. Ovo istraživanje je pokazalo važnost korištenja zadataka sa ograničenjem.

Ključne riječi: vježbe sa ograničenjem, uputstva, fudbal, korištenje prostora, toplotne mape.

INTRODUCTION

Task constraints may influence behaviour of athletes in different ways (Davids & Araújo, 2005; Davids, Button, & Bennett, 2008; Newell, 1986). The approach based on constraints (ABC approach) fits the acquisition of coordination patterns in sport (Araújo, Davids, Bennett, Button, & Chapman, 2004; Davids et al., 2008), by contemplating the actions of the performer, the characteristics of the task and the environment (Araújo, 2006).

Constraints can restrict or enable multiple behaviors that the system can adopt (Davids et al., 2008). Specifically, task constraints can help the players to center their perception on specific information. Therefore, they include the rules that constrain spatial and temporal patterns of the movement dynamics during an activity that may be open to interpretation (Handford, Davids, Bennett, & Button, 1997). It should be noted that individuals concerned with the acquisition of skill should consider the manipulation of significant constraints to achieve a desired response (Clemente & Mendes, 2011a). For instance, a soccer coach may guide the search for a movement solution by imposing a rule constraint that only allows shots from outside the penalty area (Handford et al., 1997). Accordingly, the coach can use the constraints to improve the quality of the exercise, directing the players' perception to the information considered to be relevant (Clemente, Couceiro, Martins, & Mendes, 2012a). The coach often uses the task constraints to implement the training content (Davids & Araújo, 2005). In this sense, one of the main functions of the sports coach is to identify and manipulate the most important constraints that promote self-organization of the motor system behavior in a specific game (Vilar, Castelo, & Araújo, 2010). In this viewpoint, the task constraints include the simplification of play rules, the number of players or the practice area (Figueira & Greco, 2008), focusing on the performance of the practitioners and their specific goals (Clemente & Mendes, 2011a; Clemente et al., 2012a).

In addition, the systematization of the game into subsystems, units or sub-phases allows the analysis of the game from the intra and inter-coupling between players (McGarry, Anderson, Wallace, Hughes, & Franks, 2002). Thus, it is possible to define the relationship between players and teams on three levels: 1) inter-coordination, 2) intra and inter-coordination between players, and 3) intra and inter team coordination (Travassos, Araújo, Correia, & Esteves, 2010).

Recent work on team sports studied the game sub-phases (1v1) (i.e., inter-coordination analysis), demonstrating the importance of manipulating task constraints (Araújo, 2006; Duarte et al., 2010b; Passos

UVOD

Zadaci sa ograničenjima mogu uticati na ponašanje sportista na različite načine (Davids i Araújo, 2005; Davids, Button i Bennett, 2008; Newell, 1986). Pristup zasnovan na ograničenjima (ABC pristup) odgovara stvaranju obrazaca ponašanja u sportu (Araújo, Davids, Bennett, Button i Chapman, 2004; Davids i saradnici, 2008), uzimajući u obzir akcije izvođača, karakteristike zadatka i prostora u kojem se zadatak izvršava (Araújo, 2006).

Ograničenja mogu da naprave restrikciju ili omoguće raznovrsno ponašanje koje sportista može da usvoji (Davids i saradnici, 2008). Konkretno, zadaci sa ograničenjem mogu pomoći igračima da usmjere svoju pažnju na specifične informacije. Dakle, to su pravila koja ograničavaju prostorne i vremenske obrazce u dinamici kretanja tokom aktivnosti koja se posmatra (Handford, Davids, Bennett i Button, 1997). Treba napomenuti da kod pojedinaca koji usvajaju vještine treba uzeti u obzir upravljanje značajnim ograničenjima kako bi se postigli željeni odgovori (Clemente i Mendes, 2011a). Na primjer, trener može nametnuti ograničavajuće pravilo koje zahtijeva takve kretnje koje dozvoljavaju samo šut izvan kaznenog prostora (Handford i saradnici 1997). Shodno tome, trener može da koristi ograničenja da poboljša kvalitet vježbe, usmjeravajući pažnju igrača na informacije koje smatra važnim (Clemente, Couceiro, Martins i Mendes, 2012a). Trener često koristi zadatak sa ograničenjima za provođenje sadržaja treninga (Davids i Araújo, 2005). U tom smislu, jedna od glavnih funkcija sportskih trenera je da identifikuju i da koriste najvažnija ograničenja koja unapređuju samoorganizovanje ponašanja motoričkog sistema u određenoj igri (Vilar, Castelo i Araújo, 2010). Sa ove tačke gledišta, zadatak sa ograničenjima obuhvata pojednostavljena pravila igre, broj igrača ili prostor za vježbanje (Figueira & Greco, 2008), sa naglaskom na vještinu igrača koji treniraju i specifične ciljeve zadatka (Clemente i Mendes, 2011a; Clemente i saradnici, 2012a).

Pored toga, podjela igre u podsisteme, faze ili pojedinačne akcije omogućava analizu igre iz ugla intraveza i interveza između igrača (McGarry, Anderson, Wallace, Hughes i Franks, 2002). Dakle, moguće je definisati odnose između igrača i timova na tri nivoa: 1) unutrašnja koordinacija, 2) unutrašnja i međukoordinacija između igrača, i 3) unutrašnja i međukoordinacija tima (Travassos, Araújo, Correia i Esteves, 2010).

Noviji radovi u timskim sportovima proučavali su segmente igre 1 na 1 (tj., analizu unutrašnje koordinacije), ukazujući na važnost upravljanja zadatacima sa ograničenjima (Araújo, 2006, Duarte i saradnici, 2010b;.

et al., 2008; Passos, Lopes & Milho, 2008). Constraints such as field dimension, number of players or instructions provided by the coach can be useful in order to adjust the task to the players' specificity.

Therefore, the instruction provided by the coach is one of the task constraints that influence players' intention (Clemente & Mendes, 2011b). Corroborating this, some recent studies (Araújo, 2006; Clemente & Mendes, 2011b; Clemente, Mendes, & Soler, 2011) demonstrate the pertinence of manipulating the instructions provided by the coach in order to improve the players' perception of the task, thus resulting in considerable changes in both process and product variables. In other words, within this context, the role of the feedback or the instruction may be considered as a way to amplify the environment information in order to guide the players toward finding ever improved solutions that satisfy the constraints imposed by the coach (Araújo, 2006; Davids & Araújo, 2005).

In Araújo's (2006) study of basketball players in the 1v1 game sub-phase, it was shown that different instructions triggered different decisions from players. In fact, according to the author, the situations in which the instruction was to take risks, more time in a spatio-temporal symmetry was observed.

In Clemente and Mendes (2011b) and Clemente et al. (2011), the 1v1 sub-phase in youth soccer players showed that the attacker (i.e., the player with ball possession) performed the task under the influence of three types of instructional constraints (e.g., risk, neutral and conservative). It was highlighted that in the three instructional constraints, the main objective was to successfully complete the offensive attempt, i.e., scoring the goal.

Through the analysis of the product variable (i.e., notational analysis) under-12 soccer players (Clemente & Mendes, 2011b), it was possible to verify statistically significant differences between the instructional constraints, regarding the time of the offensive attempt, bipedal recurrence, frequency to overtake the defender, the ball losses and the frequency of shots to the goal.

In summary, the reviewed studies about instructional constraints (e.g., take risks or keep the ball) suggest that it is possible to conclude that risk and conservative instructions present significant differences between them, concluding that the coach can guide the players' performance using instruction constraints, thus resulting in different actions (Araújo, 2006; Clemente & Mendes, 2011b; Clemente et al., 2011).

However, the studies about the instructional constraints only consider the notational analysis disregarding the kinematical variables, as well as the trajecto-

Passos i saradnici, 2008.; Passos, Lopes i Milho, 2008). Ograničenja kao što su veličina terena za igru, broj igrača ili upustva dobijena od strane trenera mogu biti od koristi kako bi se zadatak prilagodio specifičnostima igrača.

Dakle, upustva koja daje trener su jedan od zadataka sa ograničenjem koji utiču na ponašanje igrača (Clemente i Mendes, 2011b). To potvrđuju neke novije studije (Araújo, 2006; Clemente i Mendes, 2011b; Clemente, Mendes i Soler, 2011) ukazujući na važnost upravljanja upustvima koje daje trener sa ciljem da igrač ima bolju percepciju zadatka, a što dovodi do značajnih promjena u oba procesa i stvara raznovrsnost. Drugim riječima, u tom kontekstu uloga povratne informacije ili upustvo može da se posmatra kao način da se prošire informacije o okolini kako bi doveli igrače u situaciju da moraju da pronalaze sve bolja rješenja koja zadovoljavaju ograničenja koja je trener tražio (Araújo, 2006; Davids i Araújo, 2005).

Araújovo (2006) istraživanje igre 1 na 1 u košarci pokazalo je da različiti zadaci pokreću igrače da donose različite odluke. U stvari, prema autoru, situacije u kojima su uputstva dovodila do rizika rješenja, češće su primjećivana u prostorno-vremenskoj simetriji.

Kod Clemente i Mendes (2011b) i Clemente i saradnika (2011) izučavanje segmenta igre 1na1 kod mladih fudbalera pokazalo je da napadač (npr. igrač koji posjeduje loptu) izvodi akciju pod uticajem tri vrste zadataka sa ograničenjem (rizik, neutralni i konzervativni). Naglašeno je da u sva tri zadatka sa ograničenjem, glavni cilj je bio da se uspješno završi napada, tj. da se postigne gol.

Kroz analizu promjenljive varijable (tj. analizu kretanja) kod fudbalera mlađih od 12 godina (Clemente i Mendes, 2011b), bilo je moguće provjeriti statistički značajne razlike između ograničenja vezanih za upustva trenera, ukupnog vremena potrebnog za jedan napad, korištenja obje noge, učestalost nadigravanja odbrane, izgubljene lopte i šuteve na gol.

Ukratko, pregledna istraživanja o zadacima sa ograničenjema (npr. rizikovati ili zadržati loptu) upućuju na to da je moguće zaključiti da postoje značajne razlike između rizik zadataka i konzervativnih zadataka što nas dovodi do zaključka da trener može diktirati nastup igrača koristeći se zadacima sa ograničenjema, a što rezultira različitim vrstama akcija (Araújo, 2006; Clemente i Mendes, 2011b; Clemente i saradnici, 2011).

Međutim, istraživanja o zadacima sa ograničenjima samo preuzetim iz notacione analize zenemaruju kinematičke varijable, kao i kretanja igrača u različito zadanim uslovima. U stvari, ako se vrijeme kod

ries made by players in the different task conditions. In fact, if the time in the conservative instruction increases, it is possible that players' would perform different trajectories in order to avoid the opponent and, at the same time, keep the ball to attack in the correct instant.

Therefore, the main objective of this study is to analyze the spatial trajectories of soccer players in 1v1 sub-phase with goalkeeper. Moreover, we intend to analyze the paths performed by players on the pitch when affected by the task constraints, thus mapping the spatial trajectories of athletes with heat maps.

konzervativnih zadataka produžava, moguće je da će igrač napraviti različite kretnje da bi izbjegao protivnika i, istovremeno, zadržati loptu da bi napao u pravom trenutku.

Stoga je glavni cilj ovog istraživanja bio da se analizira prostorno kretnje fudbalera u segmentu igre 1 na 1 sa golmanom. Osim toga, namjera je bila analizirati putanje kretanja igrača na terenu kada je pod utjecajem zadatka sa ograničenjem tako što su prostorne kretnje sportista registrovane toplotnim mapama.

METHODS

Participants

This study analyzed 11 male soccer players of federated teams from Coimbra district (Portugal), of 17.91 ± 1.04 years old, and with 8.60 ± 1.52 years of practice.

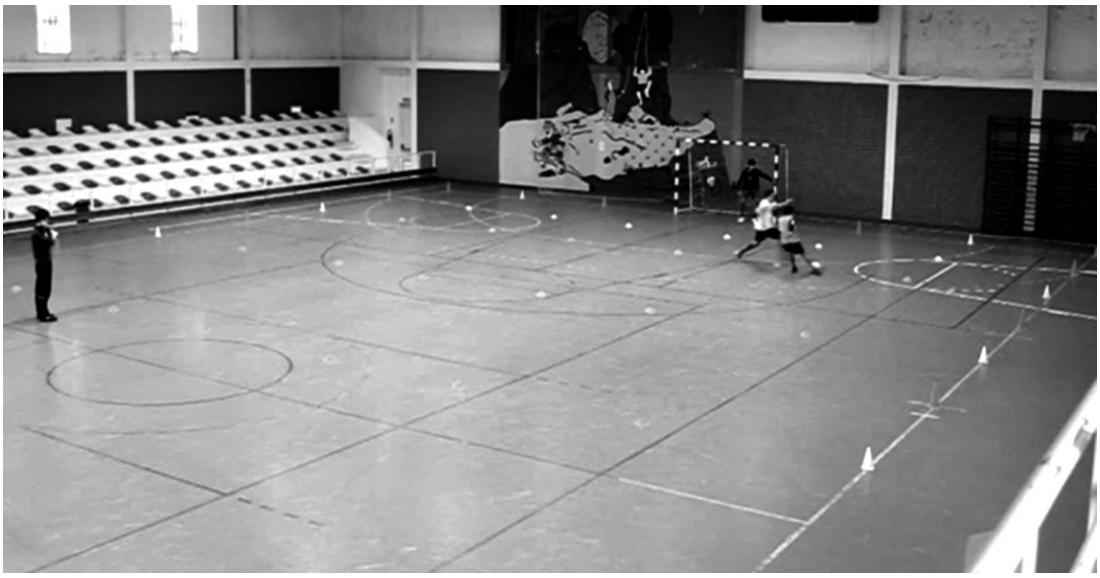
METODE

Ispitanici

Ovo istraživanje analizira 11 fudbalera muškog pola iz federalne ekipe okruga Coimbra (Portugal), starosti 17,91 ± 1,04 godina i sa 8,60 ± 1,52 godina igračkog iskustva.

Figure 1
Illustrative image of a frame obtained in the course of a trial.

Slika 1
Slika koja ilustruje dimenzije protora korištenog tokom istraživanja.



Experimental Design

A soccer game sub-phase (i.e., 1v1 with goalkeeper) was implemented in a scenario of 19.6 meters (m) wide by 18 m long, with markers at the edges of the field (Figure 1).

At the beginning of each trial, the defender was located 6 m away from the striker, positioned in the center of the field, a distance of 18 m from the goal. Moreover, the goalkeeper was restricted to his goal line.

Dizajn eksperimenta

Segment fudbalske igre 1 na 1 sa golmanom sproveden je u prostoru 19,6 metara (m) širine i 18 m dužine sa markerima na krajevima polja (Slika 1).

Na početku svakog pokušaja, odbrambeni igrač se postavlja na udaljenosti 6 m od napadača, koji se postavljao na sredini terena, na rastojanju 18 m od gola. Pored toga, golman ne smije napuštati gol liniju.

Zadatak se sastojao u realizaciji pokušaja napada

The task consisted in the realization of a soccer offensive attempt (i.e., score a goal) by the attacker in a 1v1 situation with a goalkeeper.

Task Conditions

Participants interacted in 1v1 situations with goalkeepers. Each participant performed the task under the influence of three types of instructional constraints: 1) conservative, 2) risk, and 3) neutral. In the conservative instruction, the attacker was informed that his team was winning and thus attacked whenever he had the opportunity. In the risk instruction, the attacker was informed that the game would soon end and that his team was loosing thus resulting in a risky behavior. Finally, in the neutral instruction, it was reported that the attacker should try to score a goal. In all practice conditions the main goal of the task was to score a goal.

In each of the three practice conditions (i.e., conservative, risk and neutral) 10 trials were performed. Prior to the study, an offensive attempt was provided to each participant for them to understand the main objective of the task and in order to verify if the players understood all the procedures.

In each practice condition, the attacker was told to perform the test using offensive kicking (i.e., score a goal). On the other hand, it was reported to the defender that he should prevent the goal. Before the start of each trial, the instructional constraint was provided (i.e., conservative, risk or neutral), and the attacker began its offensive attempt. All trials followed the rules of organized soccer for this age group.

Procedures

The players' actions were captured using a digital SLR (Canon EOS 500D) with capacity to process images at 30 Hz (i.e., 30 frames per second). The camera was placed at 4.53 m above ground, in the sagittal plane, to capture the whole task (Figure 1). Official soccer balls were used for this specific age group of players. An orange vest and a yellow vest were used by the attacker and the defender, respectively. The players' trajectories were analyzed using MATLAB.

After capturing the soccer offensive attempts, the physical space was calibrated using direct linear transformation (DLT), which relates the object's position (e.g., players) in the metric space with the corresponding object in the image (Duarte et al., 2010a).

The mapping allowed the construction of frequency histograms based on the spatial distribution of the attacker, thus resulting in the graphical representation of heat maps.

For this purpose, the whole scene was split in a 20 x 20 matrix resulting in a resolution lower than 1

(tj. postizanja gola) od strane napadača u situaciji 1 na 1 sa golmanom.

Uslovi zadatka

Ispitanici su uzajamno djelovali u igri 1 na 1 sa golmanom. Svaki ispitanik izvodio je vježbu tako što je dobijao tri vrste zadataka sa ograničenjem: 1) konzervativno, 2) rizik, i 3) neutralno. Kod konzervativnih zadataka, napadač je dobio informaciju da njegov tim vodi, tako da je on napadao samo kad je imao priliku za to. Kod rizik zadataka, napadač je bio informisan da utakmica ubrzo završava i da njegova ekipa gubi što je rezultiralo rizik ponašanjem. Konačno, kod neutralnih zadataka, dobijala se informacija da napadač treba da pokuša da postigne gol. Kod svih zadataka cilj je bio postići gol.

U svakom od ova tri slučaja (konzervativnom, rizik i neutralnom) izvedeno je po 10 ponavljanja. Prije istraživanja, svi ispitanici su imali po jedan napadački pokušaj da bi shvatili šta se od njih traži.

U svakom od tri slučaja, napadaču je rečeno da test završi šutem nogom (tj. postigne gol). S druge strane, odbranbenom igraču je saopšteno da treba da spriječiti postizanje gola. Prije početka svakog ispitivanja, dati su zadaci sa ograničenjem (konzervativani, rizik ili neutralni) i napadač bi započinjao sa izvođenjem napada. Svi pokušaji izvođeni su u skladu zvaničnim fudbalskim pravilima za ovu starosnu grupu.

Procedure

Napadačke akcije registrovane su digitalnim SLR fotoaparatom (Canon EOS 500D) sa kapacitetom obrade slika od 30 Hz (tj. 30 slika u sekundi). Kamera je postavljena na 4,53 m iznad tla, u sagitalnoj ravni, kako bi zabilježila cijeli zadatak (Slika 1). Korištene su zvanične lopte za ovu uzrasnu grupu igrača. Upotrebljeni su narandžasti i žuti prsluk za napadača i odbrambenog igrača. Kretanje igrača je analizirano uz pomoć MATLAB-a.

Nakon snimanja napadačkog pokušaja, fizički prostor je kalibrisan uz pomoć direktne linearne transformacije (DLT), koja se odnosi na poziciju objekta (npr. igrača) u metričkom prostoru sa odgovarajućim objektom na slici (Duarte i saradnici, 2010a).

Mapiranje omogućava konstruisanje histograma frekvencija na osnovu prostorne distribucije napadača, što rezultira grafičkim prikazom toplotnih mapa.

U tu svrhu, cijeli prizor bio je podijeljen na segmente 20 x 20 cm što rezultira podjelom manjom od 1 m^2,

m^2, thus obtaining a histogram representative of the more occupied zones of the field by a given player in a given practice condition. Figure 2 illustrates an example of a histogram.

To support the analysis of the occupied zones we proceeded to the design of heat maps. These heat maps consist of a graphical representation of the data in which the frequency values obtained by the spatial distribution histograms are represented in a two-dimensional table with different colors. The darker colors represent a higher occupation frequency in a certain area of the field.

koje određeni igrači češće zauzimaju u jednom od tri različita slučaja na treningu. Slika 2 ilustruje primjer histograma.

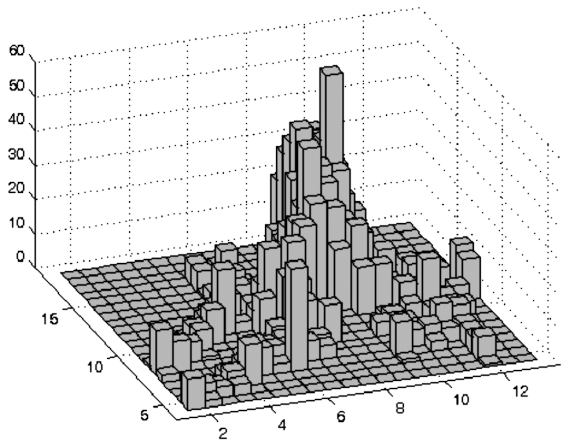
Kako bi podržali analizu zauzetih zona proveli smo dizajn toplotnih mapa. Ove topline mape sastoje se iz grafičkog predstavljanja podataka u kojima su frekvencije vrijednosti koje su dobijene na osnovu prostorne distribucije u histogramima predstavljene u dvodimenzionalnoj tebeli s različitim bojama. Tamnije boje predstavljaju veću frekvenciju zauzimanja određenog prostora na terenu.

Figure 2

Illustrative image of a histogram representative of the busiest areas of the field by a player in a given condition of practice.

Slika 2

Ilustracija slike histograma koja predstavlja najzauzitije dijelove terena od strane igrača u jednom od tri slučaja na treningu.



In addition, to analyze the traveled distance, we also proceeded to the statistical analysis of required time the attackers needs to complete the offensive attempt in each practice condition. Therefore, we used the one-way ANOVA to establish the statistically significant differences between soccer players, in each practice condition. The assumption of normality distribution of one-way ANOVA in the three practice conditions (i.e., conservative, neutral and risk) was investigated using the Kolmogorov-Smirnov test with correction Lillefors. It was found that the distributions are not normal in the dependent variable. Although it was not normal, since $n = 30$, using the Central Limit Theorem (Maroco & Bispo, 2003; Pedrosa & Gama, 2004) we assumed the assumption of normality (Akritas & Papadatos, 2004). The analysis of homogeneity was carried out using the Levene test. It was found that there is no uniformity of practice under the previously mentioned conditions. However, despite the lack of homogeneity, the *F* test

Pored toga, za analizu distanci kretanja, takođe smo napravili statističku analizu vremena potrebnog napadaču da završi akciju u svakoj od tri situacije. Stoga smo koristili jednostruku ANOVA da se utvrde statistički značajne razlike između fudbalera, u svakom od tri slučaja na terenu. Pretpostavka o normalnosti distribucije jednostruke ANOVA u svakom od tri slučaja na terenu (konzervativnom, neutralnom i rizik) ispitivana je uz pomoću Kolmogorov-Smirnov testa sa Lilleforsovom korekcijom. Utvrđeno je da distribucija za zavisnu varijablu nije normalna. Iako distribucija nije normalna, jer je $n = 30$, koristeći centralnu graničnu teoremu (Maroko i Bispo, 2003; Pedrosa i Gama, 2004) postavili smo pretpostavku o normalnosti (Akritas i Papadatos, 2004). Analiza homogenosti je sprovedena uz pomoću Leveneovog testa. Utvrđeno je da ne postoji uniformnost treninga u odnosu na predhodno navedene uslove. Međutim, uprkos nedostatku homogenosti, *F* test (ANOVA) je i dalje dobar i pored kršenja homogenosti kada je broj

(ANOVA) is robust to homogeneity violations when the number of observations in each group is equal or approximately equal (Pestana & Gageiro, 2008; Maroco, 2010; Vicent, 1999), which is the case here. As with the assumption of normality, violation of this assumption does not radically change the *F* value (Vicent, 1999). Additionally, we used the Games--Howell post hoc test (Laureano, 2011). This analysis was performed using the IBM SPSS program (version 19) for a significance level of 5%.

RESULTS

Histograms were used to quantify players' trajectories in the physical space, hence individual heat maps (Figure 3), allowing changes to be observed in the trajectories of the attacking players, subject to differentiated instructional constraints (i.e., conservative, risk and neutral).

We verified a decrease in dispersal areas covered by the attacker, under neutral and risk instructional constraints, the occurrence of vertical ball driving zones being evident, i.e., the attacker centralizes its action and trajectory toward the goal. On the other hand, due to the conservative instructional constraint, there is a trajectory of lateralization (i.e., higher occupation of the side zone), thus presenting a greater space dispersion.

Figure 4 illustrates a player's tendency to go left of the practice area. However, despite this trend, there is a gradual vertical direction of the player toward the neutral and risk instructional constraints. We hi-

zapažanja u svakoj grupi jednak ili približno jednak (Pestana i Gageiro, 2008, Maroko, 2010; Vicent, 1999), a što je ovdje slučaj. Kao i kod pretpostavki o normalnosti, kršenje ove pretpostavke nije značajno promijenilo *F* vrijednost (Vicent, 1999). Osim toga, koristili smo Games-Howell Post hoc test (Laureano, 2011). Ova analiza je provedena uz pomoću IBM SPSS programa (verzija 19) na nivou značajnosti od 5%.

REZULTATI

Korišteni su histogrami kako bi kvantifikovali kretanje igrača u prostoru. Odatle i individualne toplotne mape (Slika 3), koje omogućavaju da se zapaze promjene u kretanju napadača, a koje su posljedica kretanja po različitim zadacima sa ograničenjem (konzervativni, rizik i neutralni).

Utvrdili smo smanjenje širenja prostora koje pokriva napadač kod neutralnih i rizik zadataka sa ograničenjem, evidentnu pojavu vertikalnih zona driblinga sa loptom (npr. napadač centralizuje svoje djelovanje i kretanje prema cilju). S druge strane, kod konzervativnih zadataka sa ograničenjem, kretanje je lateralizovano (tj. veće zauzimanje zona sa strane), što predstavlja veći prostor disperzije.

Slika 4. ilustruje tendenciju igrača da idu u lijevu stranu u prostoru za vježbanje. Međutim, uprkos ovom trendu postoje i postepeni vertikalni pravci igrača kod neutralnih i rizik zadataka sa ograničenjima. Naglašavamo

Figure 3
Representative heat maps of frequency of trajectories in space.

Slika 3
Reprezentativne toplotne mape frekvencije kretanja u prostoru

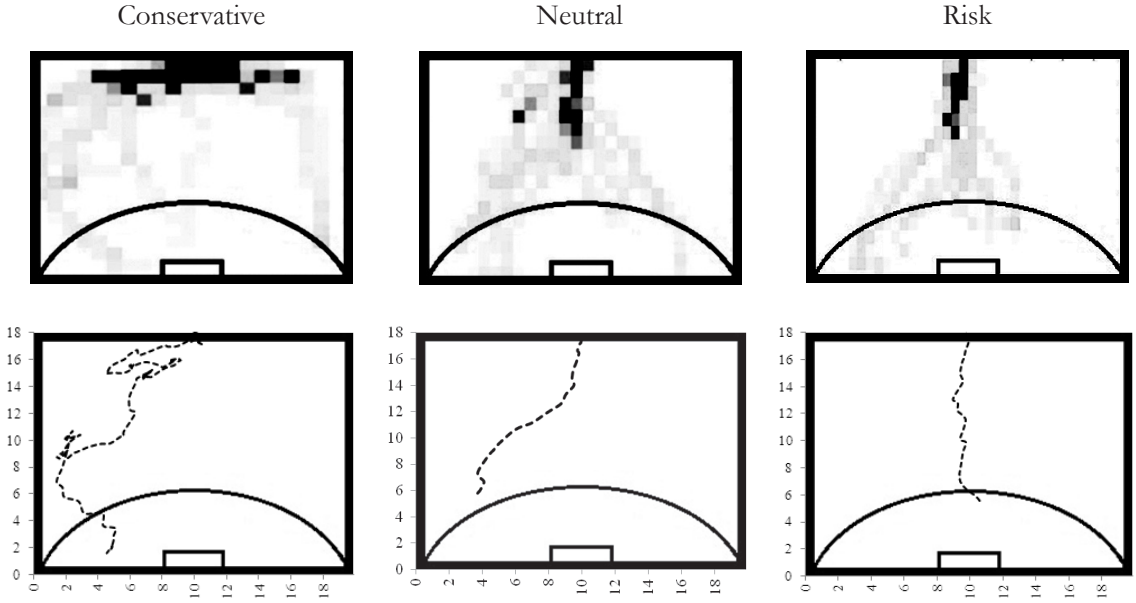


Figure 4
Representative heat maps of frequency of trajectories in space.

Slika 4
Reprezentativne toplotne mape frekvencije kretanja u prostoru.

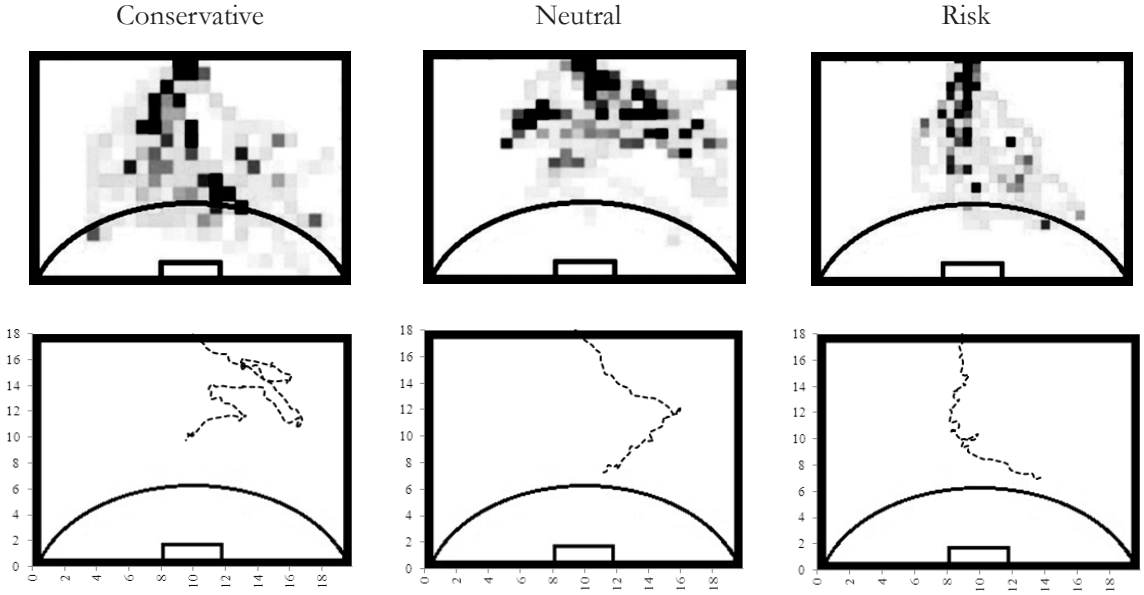


TABLE 1
Variance analysis between the 3 instructional constraints about time of offensive attempt.

TABELA 1
Analize varijanse između tri zadtaka sa ograničenjima u odnosu na vrijeme napada.

Instructional Constraints	Risk	Conservative	Neutral
Risk	-	.01**	.01**
Conservative	.01**	-	.03*
Neutral	.01**	.03*	-

* $p \leq .05$
** $p \leq .01$

Legend: Instructional Constraints - Zadaci sa ograničenjima; Risk - Rizik; Coservative - Konzervativna; Neutral - Neutralna.

ghlight the existence of trajectories in a close relation to the player's objective, when influenced by neutral and risk instructional constraints.

The one-way ANOVA made for the time of offensive attempt showed statistical differences between practice conditions ($F_{(2, 327)} = 30.776$; $p = .01$).

Specifically, the post hoc test, showed differences between risk constraints and conservative constraints ($p = .01$) and neutral constraints ($p = .01$). Under the influence of risk constraints, players took less time to complete the offensive attempt when compared to the remaining constraints. Likewise, conservative constraints presented statistically significant differences for the neutral constraints ($p = .035$), taking longer to complete the offensive attempt.

da su kretanja u skladu sa ciljevima igrača, kada se ispunjavaju neutralni i rizik zadaci sa ograničenjima.

Jednostruka ANOVA, kada je u pitanju vrijeme pokušaja napada, pokazala je statističke razlike između različitih situacija u treningu ($F_{(2, 327)} = 30,776$; $p = 0,01$).

Konkretno, post hoc test pokazao je razlike između rizik i konzervativnih ograničenja ($p = 0,01$) i rizik i neutralnih ograničenja ($p = 0,01$). Pod utjecajem rizik ograničenja igračima je trebalo manje vremena da završe napada u odnosu na druga ograničenja. Isto tako, konzervativna ograničenja pokazuju statistički značajne razlike u odnosu na neutralna ($p = 0,035$), i traže više vremena da se napada završi.

DISCUSSION

The aim of this study was to analyze the influence of instructional constraints on trajectories of the attacker. Additionally, a statistical analysis was performed in order to differentiate the time spent by the players to complete each offensive attempt in different instructional constraints.

The data shows that when players were subjected to risk instructional constraint they presented a vertical action (i.e., driving the ball toward the goal) and reduced the variability of the trajectories, thus avoiding the sidelines of the field. Similar results may be observed in Araújo (2006), where basketball players with ball possession traveled with less variability over the field in order to complete the offensive attempt in the less possible time. In risk constraints, the player's behavior is distinguished showing space-time symmetry toward the goal, thus reducing the variability of the system. Under risk constraints, the completion time is smaller and statistically significant when compared to other constraints. These results are in line with Araújo (2006), Clemente and Mendes (2011b) and Clemente et al. (2011) where players who received instructions to take risk in offensive attempt reduced the action variability in order to directly attack the goal. For instance, in Clemente and Mendes (2011b) study, it was possible to verify that in risk conditions, the attacker quickly overtakes the opponent and does not lose possession of the ball as usual. These results show that, in risk instructional constraints, players try to improve the opportunities to score by reducing the time in front of their opponent and trying to avoid him in order to follow directly to the shot, thus increasing the opportunities to score. The study by Clemente and Mendes (2011b) shows that in risk conditions the number of shots is significantly higher than in the other practice conditions (e.g., conservative and neutral). Similar results are found in the study by Clemente et al. (2011).

When the instruction to keep the ball was given, unlike the risk constraint, there was a lateralization of the action, thus increasing the variability and dispersion of the attacker's trajectories. Confirming the results of Araújo (2006), Clemente and Mendes (2011b) and Clemente et al. (2011), it was also found that there was a statistically significant increase in the time needed to complete the offensive attempt. It may be observed that the attacker exploits all the available space to maximize the possession time. However, the attempt to keep the ball may reduce the potentiality of the attacker action since he exposes more time in front of the opponent. Additionally, the results of Clemente and Mendes (2011b) show that in the conservative condition, players overtake the opponent

DISKUSIJA

Cilj ovog istraživanja bio je da se analizira uticaj zadataka sa ograničenjima na kretanje napadača. Pored toga, izvršena je statistička analiza kako bi se utvrdila razlika u vremenu potrebnom igračima za završetak svakog napada kada imaju različito postavljenje zadatke.

Rezultati pokazuju da su igrači, kada su dobili zadatke sa rizik ograničenjima, koristili direktne akcije po dubini (tj. dribling loptom prema golu), a smanjili su varijabilnost kretanja tako što si izbjegavali dijelove terena uz bočne linije. Slični rezultati mogu se zapaziti kod Araujo (2006), gdje su se košarkaši s loptom kretali s manje varijabiliteta preko terena kako bi završili napad za što je moguće kraće vrijeme. U rizik ograničenju, igračevo ponašanje odlikuje se iskazivanjem prostorno-vremenske simetrije prema cilju, čime se smanjuje varijabilnost sistema. Pod rizik ograničenjem, vrijeme za završetak napadačke akcije je kraće i statistički značajnije u poređenju sa drugim ograničenjima. Ovi rezultati su u skladu sa rezultatima Araujo (2006), Clemente i Mendes (2011b) i Clementea i saradnici (2011) gdje igrači koji su dobili instrukcije da rizikuju u napadu su smanjili varijabilnost akcija kako bi direktno napali gol. Na primjer, u istraživanju Clemente i Mendesa (2011b), moguće je vidjeti da u rizik uslovima, napadač brzo prelazi protivnika i ne gubi posjed lopte kao obično. Ovi rezultati pokazuju da, u rizik zadacima sa ograničenjem, igrači pokušavaju da povećaju mogućnost da postignu gol tako što idu direktno na svog protivnika i pokušavaju da ga zaobiđu kako bi izveli direktan šut, čime se povećavaju šanse za postizanje gola. Istraživanje Clementea i Mendesa (2011b) pokazuje da je u uslovima rizika broj šuteva znatno veći nego u drugim uslovima (konzervativnom i neutralnom). Slične rezultate nalazimo i u istraživanju Clementea i saradnika (2011).

Kada su se dobili zadatak da se lopta zadrži, za razliku od rizik ograničenja, dolazilo je do bočnih akcija, čime se povećavala varijabilnost i disperzija kretanja napadača. Takođe je zaključeno da postoji statistički zanačajno produženje vremena potrebnog za završetak napadačkog pokušaja što potvrđuje rezultate istraživanja Araujoa (2006), Clementea i Mendea (2011b) i Clementea i saradnika (2011). Da se primijetiti da je napadač koristio sav prostor na raspolaganju kako bi produžio vrijeme posjeda lopte. Međutim, pokušaj da se lopta zadrži može smanjiti mogućnosti akcija napadača jer se duže vrijeme nalazi ispred protivnika. Pored toga, rezultati istraživanja Clementea i Mendesa (2011b) pokazuju da u

more frequently than in risk conditions and also lose the ball in more occasions. These results are in line with the study by Clemente et al. (2011), which may indicate that the attacker needs to keep the ball before the shot being exposed to the opponent action, thus losing the ball in more occasions. Furthermore, it is possible to analyze in Clemente and Mendes (2011b) and Clemente et al. (2011) studies that in the conservative condition the number of shots are fewer than in risk condition.

In summary, the task constraints proved to be essential for the spatial distribution of players and the time needed for offensive attempt achievement. It was found that the spatial distribution of the attacking player varies depending on the type of instruction given. Based on the data obtained, the heat maps are particularly useful to analyze the trends of athletes' trajectories in the game field, thus learning the actions that may contribute to the notational analysis. In other words, without the use of heat maps, it would not be possible to detect the type of action that led to the decreased or increased time in the offensive attempt, in the different practice conditions. In fact, traditional quantitative analysis (i.e., notational analysis) may not be suitable to establish the whole characteristics of a specific skill or tactical behaviour. Nevertheless, the use of new methods, such as tactical metrics, may enable the overcoming of the limitation inherent to the notational analysis. Therefore, the notational or kinematical analyses need to be complemented with new methods in order for the team's tactical dynamics to be understood (Clemente, Couceiro, Martins, & Mendes, 2012b). This kind of information is vital to improve the knowledge of the game, quality of training and intervention of the coach, thus improving the collective performance of teams or players.

CONCLUSION

The instructional constraints imposed on the task proved to be important to influence the players' actions in the 1v1 game sub-phase. Within this context and given the analysis carried out above, it is clear that the instructions provided by the coach are a constraint that influences the players' performance, thus proving their potentiality to improve the quality of teaching and training exercises (Clemente & Mendes, 2011b; Clemente et al., 2011).

Moreover, the obtained data shows that it is possible to prove the importance of using new methods of kinematic analysis, such as heat maps, in order to analyze the behavioral trends and patterns of players in field.

konzervativnim uslovima, igrači se nadigravaju sa protivnikom češće nego u rizičnim kao i da više gube loptu. Ovi rezultati su u skladu sa istraživanjem Clementea i saradnika (2011), što može da značiti da napadač treba da zadrži loptu prije nego što šutne, a time je i izložen akcijama protivnika tako da je u prilici da češće gubi loptu. Osim toga, u istraživanjima Clemente i Mendese (2011b) i Clemente i saradnici (2011) pokazalo se da u konzervativnim uslovima broj šuteva je manji nego u uslovima rizika.

Ukratko, zadatak sa ograničenjima pokazao se kao bitan za prostornu distribuciju igrača i vremena potrebnog za završetak napada. Utvrđeno je da je prostorna distribucija napadača varira u zavisnosti od vrsti dobijenog zadatka. Na osnovu dobijenih podataka, za analizu vrsta kretanja sportista na terenu posebno su od koristi toplotne mape, čime analize kretanja mogu da doprinesu učenju akcija. Drugim riječima, bez upotrebe toplotnih mapa, ne bi bilo moguće otkriti vrstu aktivnosti koja je dovela do smanjene ili povećane vremena napada u različitim uslovima treninga. U stvari, tradicionalna kvantitativna analiza (notacijona analiza) možda nije prikladna za identifikovanje svih karateristika određene vještine ili taktičkog ponašanja. Ipak, korištenje novih metoda, kao što su mjerenja taktike, mogu da omoguće prevazilaženje ograničenja koji su sastavni dio notacione analize. Dakle, notaciona ili kinematička analiza treba da budu dopunjene sa novim metodama kako bi se razumjela taktička dinamika ekipe (Clemente, Couceiro, Martins i Mendes, 2012b). Ova vrsta informacije je od vitalnog značaja za uvećanje znanja u igri, kvaliteta treninga i intervencije trenera, čime se poboljšavaju kolektivni nastupi ekipa ili igrača.

ZAKLJUČAK

Upustva sa ograničenjima data u vidu zadatka pokazala su da značajno utiču na akcije igrača u segmentu igre 1 na 1. U tom smislu i imajući u vidu prethodno sprovedenu analizu jasno je da su zadaci dati od strane trenera su ograničenje koje utiče na vještine igrača, čime se ukazuje na potencijal trenera da poboljšaju kvalitet podučavanja i treniranja (Clemente i Mendes, 2011b; Clemente i saradnici, 2011).

Osim toga, dobijeni podaci pokazuju da je moguće da se dokaže važnost korištenja novih metoda kinematičke analize, kao što su toplotne mape kako bi analizirali trendove i obrasce ponašanja igrača na terenu.

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A INFLUÊNCIA DE CONSTRANGIMENTOS INSTRUCIONAIS NAS TRAJETÓRIAS DOS ATACANTES DURANTE A SUBFASE DE JOGO 1V1 NO FUTEBOL

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Introdução: Os constrangimentos da tarefa englobam, entre outros, a simplificação das regras de jogo, a redução do número de jogadores, diminuição da área de prática motora (Figueira & Greco, 2008) ou a instrução fornecida pelo treinador, focalizando a performance dos executantes em objetivos específicos. Consequentemente, os constrangimentos atuam sob diferentes formas no comportamento, influenciando o sistema motor no desempenho de vários movimentos ou habilidades motoras (Davids & Araújo, 2005; Davids, Button & Bennett, 2008; Newell, 1986). Objetivo: Considerando o exposto, o presente estudo tem com o objetivo principal analisar as trajetórias espaciais, bem como, o tempo despendido na ação dos jogadores na sub-fase de jogo 1x1 perante um guarda-redes, sob influência de constrangimentos instrucionais. Métodos: Participaram no estudo 11 futebolistas de equipas integradas no campeonato distrital, com 17.91 ± 1.04 anos de idade e com 8.6 ± 1.52 anos de prática. Cada participante realizou a ta-

refa sob influência de três tipos de constrangimentos instrucionais: 1) conservador; 2) risco e; 3) neutro. Após a recolha dos ensaios através da filmagem, calibrou-se o espaço de prática utilizando o método de transformações lineares diretas (DLT), onde se relacionou a posição do objeto (i.e., jogadores) no espaço em unidades métricas com o objeto correspondente ao plano da imagem em píxels (Duarte et al., 2010). Através do mapeamento foi possível construir histogramas com base na frequência da ocupação espacial do jogador atacante, resultando, posteriormente, na conceção de heat maps. Adicionalmente, de forma a averiguar a variância no tempo da ação de cada jogador, perante constrangimentos instrucionais distintos, aplicou-se o teste estatístico ANOVA one-way. Resultados: Através da quantificação das coordenadas no espaço de prática, foi possível verificar as alterações nas trajetórias dos jogadores atacantes, sujeitos a constrangimentos instrucionais diferenciados (i.e., conservadora, risco e neutra). Quanto ao tempo despendido pelos jogadores sob o efeito de diferentes tipos de constrangimentos instrucionais, verificaram-se diferenças estatisticamente significativas ($F_{(2, 327)} = 30.776$; $p = .01$) entre os mesmos. Discussão: Os dados mostram que, quando os jogadores eram sujeitos a constrangimentos instrucionais de risco, existia uma maior centralização da ação (i.e., condução da bola no espaço) em direção à baliza, reduzindo o foco de variabilidade para as zonas laterais do campo. Na situação onde foi concedida instrução para conservar a bola, ao contrário da instrução de risco, assistiu-se a uma lateralização da ação pelo espaço de prática, aumentando a variabilidade e a dispersão das trajetórias do atacante com bola, bem como, aumentando o tempo de ação ofensiva em cada tentativa. Conclusão: É possível constatar que a instrução fornecida pelo treinador é um constrangimento que tem influência na performance dos praticantes (Clemente & Mendes, 2011; Clemente, Mendes & Soler, 2011). Igualmente, perante os dados obtidos, os heat maps mostram-se particularmente úteis para obter as tendências e os padrões do comportamento dos jogadores face ao seu percurso no terreno de jogo.

Palavras-chave: Constrangimentos da tarefa, instrução, futebol, espaço ocupado, gráficos de calor.

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PERCEPCIJA PEDAGOŠKE PRAKSE NASTAVNIKA FIZIČKOG VASPITANJA U PORTUGALU OD 1970-ih

PERCEPTIONS OF PEDAGOGICAL PRACTICES OF PHYSICAL EDUCATION TEACHERS IN PORTUGAL SINCE THE 1970S

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SUMMARY

The aim of this study is to analyse how Physical Education teachers in Portugal organise their lessons, taking into consideration the most valued lesson models. Moreover, we sought to understand the existing relationship between those practices, their experiences, attitudes and the influence of training schools, ie, the existing relationship between pedagogical work and a *habitus*, seen as a product of history and a defining principle of group and individual practices learned empirically in specific contexts. Based on a qualitative methodology, the study focused on a group of fifteen teachers with varied degrees in Physical Education, who graduated from some of the most distinguished schools in Portugal, for e.g., the National Institute of Physical Education, Colleges of Physical Education, and some of the most famous Portuguese faculties in this field of study established in the early 1990s. We concluded that these teachers defend the use of well structured classes, based on strict planning, not neglecting students' motivations. Moreover, that the existence of different pedagogical practices (and attitudes) is possible due to different training, to the specific historical context and different experiences, personalities and motivations of each teacher. These differences suggest, therefore, there is a relationship between pedagogical practices and a *habitus*, which means experiences acquired in different cultural, political and educational environments.

Key words: pedagogical practices, physical education; teachers.

SAŽETAK

Cilj ovog istraživanja je da analizira kako nastavnici fizičkog vaspitanja u Portugalu organizuju svoju nastavu, uzimajući u obzir različite nastavne modele. Osim toga, pokušali smo da shvatimo postojeći odnos između toga u praksi, nastavnikovog vlastitog iskustva, formiranih stavova i uticaja završenog obrazovanja u ovoj struci, odnosno postojećeg odnosa između pedagoškog rada i *habitusa*, posmatranog kao proizvoda istorijskih okolnosti, kao i definisanih pricipa empirijskih saznanja u grupnoj i pojedinačnoj praksi u specifičnim kontekstima. Na osnovu kvalitativne metodologije, istraživanje je usmjereno na grupu od 15 nastavnika s različitim nivoima obrazovanja, od kojih su neki završili neke od najuglednijih škola u Portugalu, npr. Nacionalni institut za fizičko vaspitanje, a neki najpoznatije portugalske fakultete na ovom polju studija osnovane početkom 1990-ih. Došli smo da zaključka da nastavnici preferiraju dobro strukturirane časove, na osnovu jasnog planiranja, a ne zanemarujući pri tom motivaciju učenika. Štaviše, postojanje različitih pedagoških praksi (kao i stavova), je moguće zbog različitog načina studiranja u specifičnom istorijskom kontekstu kao i različitih iskustava, ličnosti i motivacije svakog nastavnika. Ove razlike ukazuju da postoji veza između pedagoške prakse i *habitusa*, što znači iskustva stečenog u različitom kulturnom, političkom i obrazovnom okruženju.

Ključne riječi: pedagoška praksa, fizičko vaspitanje, nastavnici.

INTRODUCTION

Physical Educational in Portugal during the 20th and early 21st centuries has been marked by many changes that have influenced its conceptual and methodological course (Moreira, 2011), with effects evident in the pedagogical practices adopted by Physical Education teachers. To understand these changes in practices, we need to consider the Physical Education teacher in his or her *habitus*, in the different scenarios in which he or she works, whether in terms of profession or of training (initial and continuing), or in personal terms, subject to the influence of personal and professional experiences (Borges, 2003; Lahire, 2002; Rezer, 2007).

Bourdieu (2005) sees this *habitus* as a system of durable arrangements which, integrating all past experiences, works at every moment as a matrix that generates representations, perceptions and practices, making it possible to carry out infinitely different tasks thanks to the analog transfers of schemes, which allow problem-solving in the same way, and the endless corrections of results obtained, dialectically produced by these results. In the same line of reasoning, Silva (2005) assumes it as a product of history and a defining principle of individual and group practices that can be learned empirically.

In turn, Borges (2003) argues that much of the knowledge underlying Physical Education teachers training is the result of the experiences they acquire in their professional career (from the period of initial training), in the development of pedagogical activities experienced in institutions where they taught, and highlights the idea that *habitus* is the pedagogical practice of teachers through the incorporation of lived experiences and repetition of successful ideas. Thus, the *habitus* of teachers encompasses knowledge built not only throughout the teaching practice, but also along the training course, as a higher education student and as a non-higher education student (Sanchotene & Molina Neto, 2010).

Therefore, in examining the teachers' practice, we felt it was necessary to examine the ways of being in the profession and how they feel towards the profession, but also examine the paths of their initial training and the contexts that defined how they face the profession. These contexts were crucial to how these teachers performed, because in the 1970s, and especially in the 1990s, with the substantial increase (Brás, 1996) of Physical Education training schools in Portugal, many courses were established with very heterogeneous curricular structures and contents, which contributed to enhance the diversity of practices and different "Physical Educations" that have been in contact at the same time and in the same spaces, similar to a crossroads of different parallel dimensions in the same reality, forming, as understood by Lovisolo (1995), different "tribes" that use

UVOD

Fizičko vaspitanje u Portugalu tokom 20. i početkom 21. vijeka obilježeno je mnogobrojnim promjenama koje su uticale na njegov konceptualni i metodološki pravac (Moreira, 2011), s očiglednim efektima na pedagošku praksu usvojenu od nastavnika fizičkog vaspitanja. Da bi se shvatile ove promjene u praksi, moramo posmatrati nastavnika fizičkog vaspitanja u njenom ili njegovom *habitusu*, u različitim uslovima u kojima on ili ona radi, ili u smislu njihovog obrazovanja (početnog i kontinuiranog), ili u pristupu, pod utjecajem ličnog i profesionalnih iskustva (Borges, 2003; Lahire, 2002; Rezer, 2007).

Bourdieu (2005) vidi ovaj *habitus* kao sistem trajnih rješenja koja, integrišući sva iskustva iz prošlosti, djeluju u svakom trenutku kao matrice koje generišu predstave, shvatanja i praksu. Time je moguće provesti lepezu različitih zadatka zahvaljujući odgovarajućoj tranziciji koja omogućava rješavanje problema na isti način i korigovanju dobijenih rezultata koji proizilaze iz dijalektičkog pristupa. Razmišljajući na isti način, Silva (2005) ga podrazumijeva kao proizvod istorije i definisanja principa individualne i grupne prakse koja se može praktično učiti.

S druge strane, Borges (2003) tvrdi da su mnoga funadmentalna znanja obrazovanja nastavnika fizičkog vaspitanja rezultat iskustva koja su stekli u svojoj profesionalnoj karijeri (iz perioda dok su studirali) i razvoja pedagoških aktivnosti kroz iskustvo u ustanovama gdje su predavali. On misli da je *habitus* pedagoška praksa nastavnika kroz inkroporaciju proživljenih iskustava i ponavljanje uspješnih ideja. Tako, *habitus* nastavnika obuhvata znanja izgrađena ne samo kroz nastavnu praksu, nego i u procesu obrazovanja, kako kod studenata sa visokim obrazovanjem tako i kod oni koji to nemaju (Sanchotene i Molina Neto, 2010).

Stoga, u proučavanju prakse nastavnika, smatrali smo da je neophodno da se ispitaju primjenjene metode i kako one utiču na struku, ali i da ispitamo načine metodičke obuke u vlastitom obrazovanju, te kontekste koji definišu kako oni to primjenjuju u nastavi. Ovaj kontekst je bitan za rad nastavnika, jer su tokom 1970-ih, a posebno 1990-ih, sa povećanjem broja (Brás, 1996) obrazovnih ustanova iz oblasti fizičkog vaspitanja u Portugalu, uspostavljeni mnogi studiji sa različitom strukturom i sadržajem nastavnog plana i programa. To je doprinjelo većoj raznolikosti prakse i različitosti "fizičkog vaspitanja" koje su bile u kontaktu u isto vrijeme i na istim prostorima, slično raskrsnicama različitih paralelnih dimenzija u istoj stvarnosti Lovisolo (1995). Različita "plemena" koja koriste različite

different "languages", with reflections evident in their attitude and practice.

On the basis of these assumptions, we developed a study that aims to understand the existing relationship between those pedagogical practices and their experiences, attitudes and the influence of training schools, ie., the existing relationship between pedagogical work and a *habitus*, seen as a product of history and a defining principle of group and individual practices learned empirically.

METHODS

As already mentioned, the aim of this study is to analyse how a group of Physical Education teachers of Portuguese basic education schools (7th, 8th and 9th years of schooling) and secondary education schools (10th, 11th and 12th of years of schooling) organise their practices. The nature of this research led us to consider a qualitative study in which direct speech submits to an interpretative logic, which in framing and explaining the position of the interviewed teachers intends to describe how Physical Education teachers relate within their subject group in the current Portuguese school context.

To stimulate the materialization of study data, we resorted to the use of semi- directed interviews, also called clinical or structured interview, and to analyse the data from this interview we used a research technique that encodes the apparently disordered statements: the analysis of contents (Bardin, 1977; Krippendorf, 1980; Vala 1986).

Our sample consisted of a group of fifteen interviews to teachers (Table 1) with different initial training in Physical Education, taken at well known institutions of our country during the 20th century: the National Institute of Physical Education (INEF in Portuguese), created in 1940, marking a truly significant moment in terms of Physical Education teachers' training in Portugal (Ferreira, 2002); the Schools of Physical Education Instructors (EIEF in Portuguese), created in 1969; the College of Physical Education (ISEF in Portuguese) in Lisbon and Porto, created in 1975 following the implementation of democracy in Portugal; the Faculties of Science, Sports and Physical Education (FAC in Portuguese), that proliferated from the early 1990s.

After deciding to study this group of professionals, we selected it in a non-random way without looking for a "representative" objective, given the qualitative nature of the methodology. This selection sought to ensure the greatest possible diversity of experience and personal characteristics, and was based on initial training courses (training institutions). With this pro-

"jezika", sa evidentnim refleksijama na njihove stavove i praksu.

Na osnovu ovih pretpostavki, razvili smo studiju koja ima za cilj da shvati postojeći odnos između ovih pedagoških praksi i iskustava, stavova i uticaja vlastitog obrazovanja nastavnika, tj, postojeći odnos između pedagoškog rada i *habitusa* gledajući na to kao na proizvod istorije i definisanja principa grupne i individualne prakse empirijski stečene.

METODE

Kao što je već pomenuto, cilj ovog istraživanja bio je da analizira kako grupa nastavnika fizičkog vaspitanja portugalskih osnovnih (7, 8. i 9. razred) i srednjih škola (10, 11. i 12. razred) organizuje svoju nastavu. Sama priroda ovog istraživanja nas je navela da upotrijebimo kvalitativnu metodu analize koja omogućava ispitivanje dobijenih odgovora na nivou interpretativne logike, koji, kada su pozicije nastavnika jasne i eksplicitne, postaju osnova konteksta trenutnog stanja u portugalskim školama.

U cilju stimulisanja materijalizacije podataka istraživanja, koristili smo polu-usmjerene intervjue (klinički ili strukturirani intervju), a za analizu podatka koristili smo istraživačku tehniku koja omogućava kodiranje naizgled nepovezanih činjenica: analizu sadržaja (Bardin, 1977; Krippendorf, 1980; Vala 1986).

Uzorak našeg istraživanja obuhvatilo je petnaest nastavnika fizičkog vaspitanja sa kojima su obavljeni intervjui (Tabela 1) sa različitim akademskim ili drugim iskustvima. Ovu grupu činili su diplomirani nastavnici i profesori fizičkog vaspitanja priznatih portugalskih institucija: Nacionalni institut za fizičko vaspitanje (INEF na portugalskom), osnovan 1940, koji predstavlja zaista značjan faktor u obrazovanju nastavnika fizičkog vaspitanja u Portugalu (Ferreira, 2002); Škola za instruktore fizičkog vaspitanja (EIEF na portugalskom), formirana 1969. godine; Visoka škola za fizičko vaspitanje (ISEF na portugalskom) u Lisabonu i Portu, osnovana 1975 kao posljedica uvođenja demokratije u Portugalu; Fakultet za sport i fizičko vaspitanje (FAC na portugalskom) osnovan početkom 1990-ih godina.

Nakon što smo se odlučili za namjeran uzorak u smislu stručnjaka iz navedene oblasti metodom slučajnog izbora su odbarani "reprezenti" koji će odgovoriti našem cilju i kvalitativnom karakteru metodologije rada. Ovakav način selekcije osigurava najviši nivo diverzifikacije ličnog karaktera i iskustava, a sa posebnim naglaskom na različitost ustanova sa kojih ispitanici dolaze. To je doprinjelo da se uzorak sa kojim smo radili sastoji od prosvjetnih radnika sa

cedure, we wanted our sample to be made up of teachers who had different training courses in different historical periods, with different lengths of service and career positions, in order to come close to the concept of maximum variation sample.

Before presenting the results, we think it is important to note that the analysis of resulting data obeyed a logics of operation based on the alternation of two phases. Initially, we carried out a vertical analysis of each interview of teachers trained in different schools, and then we performed a horizontal or comparative analysis using the "constant comparative analysis method" (Miles & Huberman, 1994) in order to identify common and distinctive aspects of the teachers' representations and perceptions. To this end, we present the information from the interview in tables as well, to illustrate the relevance of some of their opinions. We believe that this organisational model of information, which allows us to study the perceptions of teachers in a systematic way, will provide us with a more adequate view of their ideas.

različitim obrazovanjem, nastavnika koji su različite starosne dobi, i koji su imali različito radno iskustvo i radni staž u prosvjeti. Ovo nas je približilo konceptu uzorka sa maksimalnim stepenom varijabilnosti.

Prije nego što interpretiramo rezultate važno je napomenuti da analiza podataka ispunjava logiku koja se zasniva na smjenjivanju dvije faze. U početku smo sproveli vertikalnu analizu svakog pojedinačnog intrevjua sa nastavnicima koji su svoje obrazovanje stekli u različitim institucijama, a zatim smo obavili horizontalnu ili komparativnu analizu pomoću "metode kontinuirane komparativne analize" (Miles i Huberman, 1994) kako bi se utvrdili zajednički i različiti aspekti izjava i shvatanja nastavnika. U tom smislu, predstavili smo podatke iz intervjua u tabelama da bi ilustrovali relevantnost njihovih određenih razmišljanja. Vjerujemo da će ovakav način analize podataka, koji nam omogućava proučavanje percepcije nastavnika na sistematičniji način, dati adekvatniji prikaz njihovih razmišljanja.

TABLE 1
Study sample.

TABELA 1
Uzorak na kome je rađeno ispitivanje.

Codes of interview	Institutions of Initial Formation
E2, E13, E14	Instituto Nacional de Educação Física (INEF)
E10, E12	Escola Instrutores de Educação Física (EIEF)
E1, E4, E7, E8, E10, E11	Institutio Superior de Educação Física (ISEF)
E3, E5, E6, E9, E15	Faculdades de Desporto de Educação Física (FAC)

Legend: Codes of interview - Kod intervjua; Institutions of Initial Formation - Institucije za početno obrazovanje.

RESULTS

Representation of teachers trained up to the 1970s - INEF and EIEF

With regard to the representations of teachers trained in INEF and EIEF, we have, in this area, records distributed by the characterisation of the Physical Education class and by the analysis of the different attitudes and practices in the teaching of this discipline. It should be noted that these teachers had initial training before 1975, when their training institution underwent major changes and changed their name to College of Physical Education.

A lesson is never a harmless act. It always contains an educational activity that cannot be ignored. The construction of the lesson, according to Pieron (1984), raises a set of concerns that will constrain its structure and organisation, for example, which activities

REZULTATI

Izjave nastavnika školovanih do 1970-ih - INEF i EIEF

Na uzoraku koji su činili nastavnici koji su diplomirali na INEF i EIEF utvrđena je raspodjela obilježja nastave fizičkog vaspitanja i analiza različitih stavova i radnog iskustva u ovoj oblasti. Treba napomenuti da su ovi nastavnici završili obrazovanje prije 1975. godine od kada je njihova obrazovna institucija prošla kroz velike promjene i dobila novo ime: Visoka škola za fizičko vaspitanje.

Školovanje nikad nije beznačajno držanje časa. Ono sadrži obrazovnu aktivnost koja se ne može zanemareiti. Konstruisanje časa, prema Pieronu (1984), postavlja niz problema koja ograničavaju njegovu strukturu i organizaciju, npr. koje aktivnosti treba da

should be suggested, which teaching style should be adopted, or which models should be used (Table 2).

Teacher -E13-, as seen in the first example record, when asked about the lesson model she values most, points out that whilst defending a lesson more focused on the student's motivations, does not neglect the planning of her lessons.

budu predložene, koji nastavni stil treba da bude usvojen ili koji model treba koristiti (Tabela 2).

Nastavnica -E13-, kao što se može vidjeti u prvom primjeru, na pitanje o modelu časa koji najviše cijeni, odgovara da je pristalica nastave koja je više usmjerena na motivaciju učenika, ali pri tom ne zanemaruje planiranje svojih časova.

TABLE 2
Representations of teachers from INEF/EIEF.

TABELA 2
Izjave nastavnika sa INEF/EIEF.

S	Record
E13	I defend a class more focused on students' motivations, although I always have a previously outlined structure.
E12	I think so. The different training, contexts, experience and personality of each teacher contribute to those different practices and attitudes.

Legend: **S** - Codes of interview (Kod intervjua); Record - Zapis; E13 - Pristalica sam nastave koja je više usmjerena na motivaciju učenika, iako uvijek imam peethodno pripremljenu strukturu časa; E12 - Mislim da je tako. Različita obuka, objašnjenja, iskustvo i ličnost svakog nastavnika doprinosi različitosti prakse i stavova.

This issue of planning is, in fact, very important, because the planning of any activity, including teaching, according to Arends (1995) improves the results of student learning. The research conducted by Pereira (2002), who sought to establish whether Physical Education teachers plan their lessons, revealed that 76.2% of teachers actually plan them; however, the same study showed that they devoted little time to this planning, which is nonetheless worrying.

Regarding its structure, the teacher always starts her classes "*[…] with a warm up to the activity being taught. Then we get to the didactic part, or if I see that they need to relax, I let them follow their motivations, and sometimes the lesson ends like this, because there is no time for more [...]*". In her opinion, all exercises and games are important, but she particularly likes "*[…] group games directed to the development of social skills. Sometimes, I give priority to games involving group dynamics*".

Another teacher from INEF, -E14-, with a slightly different idea, admits that, for many years, he was in favour of a more structured lesson, especially to contradict the rooted idea that nothing happened in the Physical Education class. One of his greatest struggles, as was the prerogative of teachers graduated in INEF, was always to try to change the image that the school and surrounding community had of Physical Education. After this "struggle", in his last days as a teacher, he focused more on the motivations of students. His classes, he says, were always: "*[…] well structured, with an initial warm up period according to*

Ovo pitanje planiranja je, u stvari, veoma važno, jer planiranje bilo kakve aktivnosti, uključujući i nastavu, prema Arendsu (1995) poboljšava rezultate učenika. Istraživanje koje je sproveo Pereira (2002), tražeći da se utvrdi da li nastavnici fizičkog vaspitanja planiraju svoju nastavu, pokazalo je da je 76,2% nastavnika planira. Međutim, isto istraživanje je pokazalo da su oni malo vremena posvetili ovom planiranju, što je veoma zabrinjavajuće.

Nastavnica o strukturi početka časa kaže: "*[...] sa zagrijavanja na aktivnostima koje će predavati. Onda dolazimo do didaktičkog dijela, ili ako vidim da im je potrebno da se opuste, pustim ih da prate svoje motive i ponekad čas završava tako, jer nema vremena za više [...]*". Po njenom mišljenju, sve vježbe i igre su važne, ali ona posebno voli "*[...] grupne igre usmjerene na razvoj socijalnih vještina. Ponekad , dajem prednost igarama koje uključuju grupnu aktivnost*".

Još jedan nastavnik sa INEF-a, -E14-, sa nešto drugačijim mišljenjem, tvrdi da je godinama preferirao unaprjed pripremljene časove, iako je uvriježeno mišljenju da se časovi fizičkog vaspitanja ne isplaniraju. Njegova osnovna težnja, kao nekog ko je imao čast da diplomira na INEF-u, je da pokuša promijeniti sliku u školama i lokalnoj zajednici o fizičkom vaspitanju. Poslije ove "bitke", u svojim poslednjim danima nastavničke karijere, on je više usmjeren na motivaciju učenika. Njegovi časovi, kaže on, uvijek su bili: "*[...] dobro strukturirani, s početnim periodom zagrijavanja u skladu sa sportskom aktivnošću. Onda je dolazio didaktički dio, i*

the sports activity. Then came the didactic part, and at the end the fun part".

Regarding the structure of the lesson, the EIEF -E12- teacher feels that there should be a previously outlined structure, adapted "*gradually to the motivations of students. Normally, her classes start […] with a specific warm up period directed at the activity students will engage in. Then I give them the didactic component, and finally there's a period of relaxation, if there is time for it.*" This seems to be a very logical system supported among teachers of Physical Education. Rodrigues (1994) conducted a study which focused on the construction and organisation of Physical Education classes, in which he defends the most important moments of a class. Similarly to the teachers of our study, Rodrigues defends a class divided into three distinct moments: initial or preparatory, the body or key part of the class, and the final part or closure. The first part of the session consists of two moments: first, when students have not started the class yet and are getting ready to enter the gym; second, the actual class, with students prepared to start activities. This last period may consist of two phases: one in which the teacher makes an oral presentation of the contents and/or activities; another, an active part or "warm up", which may eventually take place before the oral presentation of activities. The main part of the lesson aims to achieve the operational objectives defined for that class. The final part aims to lower the active state of students, using for that effect some flexibility exercises, stretching and/or relaxation. This part may be used to achieve the objectives of social-emotional and/or cognitive control. As we will see, most teachers involved in our research, from all training schools, in a more or less systematized way, and in more or less detail, ultimately define a structure very similar to the one described and defined by this researcher.

With regard to the existence of different attitudes and practices within the professional group, all teachers in this group are unanimous in admitting that differences exist. As we will see in the second example records in Table 2, the teacher from EIEF feels that these different practices exist and are justified, especially due to different training, different contexts and experiences of each teacher, and different personalities. She adds that it is normal "*[…] for teachers who hop from school to school to have a wealth of different experiences, and a better notion of those practices*".

Teachers -E13 and -E14- emphasise too the issue of different training and individual experiences. While the first teacher notes that: "*[…] the proliferation of training courses and new sports contributed to the different practices found in schools*", the second teacher chooses to highlight only initial training as a determining factor. In his opinion, "*[…] initial training is the factor*

na kraju zabavni dio".

S obzirom na strukturu nastave, EIEF-ov nastavnik -E12- smatra da treba postojati prethodno pripremljena struktura, prilagođena "*postepenoj motivaciji učenika. Normalno, njena nastava počinje [...] sa periodom specifičnog zagrijavanje usmjerena na aktivnosti u koje će učenici biti uključeni. Zatim im dajem didaktičku komponentu, i na kraju postoji period opuštanja, ako za njega ima vremena.*" Ovo izgleda kao vrlo logičan sistem koji je podržan među nastavnicima fizičkog vaspitanja. Rodrigues (1994) je sproveo istraživanje koje je bilo usmjereno na planiranje i organizaciju nastave fizičkog vaspitanja, u kojima on ističe najvažnije trenutke u nastavi. Slično kao i kod nastavnika u našem istraživanju, Rodrigues brani nastavu podijeljenu na tri različita dijela: početni ili pripremni, glavni ili ključni dio nastave i završni dio ili "zatvaranje". Prvi dio časa sastoji se od dvije cjeline: prvi, kada učenici nisu počeli sa časom i još se spremaju da uđu u salu i drugi, stvarni čas, sa učenicima spremnim za početak aktivnosti. Ovaj posljednji period može da se sastojati od dve faze: jedne u kojoj nastavnik usmeno predstavlja sadržaja i/ili aktivnosti i druge, aktivni dio ili "zagrijavanje", koju eventualno može da održi prije usmene prezentacije aktivnosti. Glavni dio nastave ima za cilj postizanje operativnih ciljeva definisanih za taj čas. Završni dio ima za cilj da organizam učenika dovede u stanje opuštanja koristeći u tu svrhu neke vježbe fleksibilnosti, statičkog istezanja i/ili opuštanja. Ovaj dio može se koristiti za postizanje ciljeva socijalno-emocionalne i/ili kognitivne kontrole. Kao što ćemo vidjeti, većina nastavnika koji su uključeni u naše istraživanje, koji su se školovali u različitim ustanovama, na manje ili više sistematizovani način, sa više ili manje detalja, definišu strukturu vrlo sličnu ovoj koju opisuje i definiše ovaj istraživač.

S obzirom na postojanje različitih stavova i iskustva u okviru poduzorka, svi nastavnici u ovoj grupi se jednoglasno slažu da razlike postoje. Kao što ćemo vidjeti u drugom primjeru, u Tabeli 2, nastavnica sa EIEF-a smatra da ove razlike u praksi postoje i da su opravdane, posebno zbog različitog obrazovanja, različitih konteksta i iskustva svakog nastavnika kao i različitih njihovih ličnosti. Ona dodaje da je to normalno "*[...] za nastavnike koji prelaze iz škole u školu da imaju bogatstvo različitih iskustava i bolju spoznaju istih*".

Nastavnici -E13 i -E14-i previše naglašavaju pitanje različitog obrazovanja i individualnih iskustava. Dok prvi nastavnik primjećuje da: "*[...] povećavanje programa obrazovanja i uvođenje novih sportova doprinjelo je različitim praksama koji se sreću u školama*", drugi nastavnik izabrao je da istakne, kao odlučujući faktor, samo vlastito početno obrazovanje. Po njegovom mišljenju, "*[...] početno obrazovanje je faktor koji utiče na to kako većina*

that influences the most how the Physical Education teacher performs. The training school leaves a mark for ever. Sometimes, this mark is embedded deeper than it should [...]".

Representation of teachers trained during the 1970s and 1980s - ISEFs

In respect of the representations of teachers trained at the ISEFs, we have sixty-two records, equally distributed on the basis of how they describe their classes and their work.

In their approaches to the construction of the lesson itself, most of the teachers trained at the ISEFs advocate a very structured lesson based on strict planning, not neglecting, however, the issue of student motivation, thus confirming the results of the previously cited work by Pereira (2002), which shows the importance that Physical Education teachers assign to planning, as it can enable a better structuring of the students' learning progress, ensure better class organisation and management, and boost the confidence of the teacher.

As we can see in the first example record (Table 3), when asked about the lesson model she values most, teacher -E4- refers that this issue is difficult to answer, because the situation often depends on external factors that are difficult to control, such as the motivation and mood of students. Showing a con-

nastavnika fizičkog vaspitanja izvodi časove. Institucije u kojima su obrazovani ostavlja zauvijek trag. Ponekad, je ovaj trag utisnut dublje nego što bi trebao [...]".

Izjave nastavnika školovanih tokom 1970-ih i 1980-ih - ISEFs

Što se tiče nastavnika školovanih na ISEFs-u, dobili smo šezdeset i dve izjave na osnovu kojih je utvrđeno kako oni opisuju svoje časove i svoj rad.

U svojim pristupima izgradnje same nastave, većina nastavnika školovana na ISEFs-u zagovara strogo strukturirane časove zasnovane na planiranju, ne zanemarujući pritom pitanje motivacije učenika. Time se potvrđuju rezultati prethodno citiranog rada Pereira (2002), koji ukazuje na značaj koji su nastavnici fizičkog vaspitanja dali planiranju. Smatraju da to može omogućiti bolje struktiriranje procesa učenja đaka, obezbjeđujući pri tom bolju organizaciju i upravljanje nastavom, kao i povećanje povjerenja u nastavnika.

Kao što možemo vidjeti u prvom primjeru intervjua (Tabela 3), na pitanje o modelu nastave koji ona najviše preferira, nastavnica -E4- misli da je na ovo pitanje teško precizno odgovoriti, jer situacije često zavise od spoljnih faktora koje je teško kontrolisati, kao što su motivacija i raspoloženje učenika. Iskazujući konformistički stav, ona kaže da kada se učenik ponaša

TABLE 3
Representations of teachers from ISEFs

TABELA 3
Izjave nastavnika sa ISEF.

S	Record
E4	The typical class always depends on many external factors, which the Physical Education Teacher is not always able to control. It depends on the motivation and mood of students, depends on the discipline and activity they had before. For example, if they had a 12th year test that didn't go well, however hard we try there's nothing we can do. At such times, I tell them to go home, to disappear, because it's not worth them being there.
E7	Yes, always. Different teachers with different training. In some schools, we had five or six Physical Education teachers with different training, which will not in any way benefit the discipline.

Legend: **S** - Codes of interview (Kod intervjua); **Record - Zapis; E4 - Tipičan čas uvijek zavi**si od mnogih spoljnih faktora koje nastavnici fizičkog vaspitanja nisu uvijek u stanju da kontrolišu. To zavisi od motivacije i raspoloženja učenika, zavisi od discipline i aktivnosti koju su imali prije toga. Na primjer, ako su učenici 12. razreda imali test koji nije prošao dobro, koliko se god mi trudili ništa nećemo moći da uradimo. U takvim trenutcima samo im kažem da idu kući, da nestanu, jer ne vrijedi da su tu; E7 - Da uvijek. Razni nastavnici, različito školovani. U nekim školama, mi smo imali pet ili šest nastavnika fizičkog vaspitanja različito školovanih, što ni na koji način neće koristiti disciplini.

formist attitude, she says that when a student is in an uncontrollable mood, she sends him or her home. However, she has no doubts in describing how a typical Physical Education should not be like, a situation that has happened to her a few times as a student: "*I had a teacher before 25 April 1974, when the democratic rule was established in Portugal, who always came to school at 8 am holding a ball, he would sign the log-book for the whole day, go out for coffee sometimes, and at lunch time he would come back to pick up his ball. This is definitely a Physical Education class [...]*".

With regard to the sub-division of the Physical Education class, according to this teacher it "*must have a warm-up period and a flexibility period. Then the didactic unit being taught. The fun part, the game and fitness according to contents must also be part of the lesson, and at the end stretching exercises and relaxation. Only sometimes this is not easy to pull through [...]*" (UR[1] 10). It follows, therefore, a very consensual structure, which Rodrigues (1994) feels is adequate.

Teacher -E7- expresses a line of thought that is typical of these teachers, noting that he likes well structured and planned classes, but is aware that they need to be flexible because adopting a tough stance may cause some constraints. From his experience and knowledge, he states that: "*[…] depending on the classes, we have to adopt different strategies. Later, he points out that it is often necessary to value the motivation part and the sports dynamics, where there is more freedom and the lesson is given in the sense of a game, which pleases the student*". When preparing his classes, this teacher prefers the integrating activities. He says: "*[…] if I'm teaching basketball or volleyball, there is no sense in running around without a ball. All the activities should be focused on the actual sport, and integrated. If the student has to master the dribble, then he or she will warm-up playing the ball*".

The position of teacher -E8-, also from ISEF in Porto, is very similar to that of the former teacher, as regards the planning of lessons. He defends the ideal of having well structured lessons, and is aware that it is necessary to meet students' motivations. In this sense, he is very critical of teachers who: "*[…] often forego the pre-defined structure just to please the students, neglecting the important exercises needed to learn a particular sport. This is why sometimes students reach the 12th year without knowing, for example, how to make a left pass using the left hand*". And he concludes, in this regard, that we need to be aware that: "*[…] in Physical Education classes there is much time for playing around, but there is also a time for more 'serious' learning. All disciplines have objectives to be met, and if I can achieve that objective in a playful way, fine, but sometimes it is not easy to find 'games' for everything*".

[1]UR - Unit of register

neobuzdano, ona ga šalje kući. Ipak, ona nema dileme kada opisuje kako tipičano fizičko vaspitanje ne bi trebalo da bude kao što je situacija koja joj se dogodilo nekoliko puta dok je i sama bila đak: "*Imala sam nastavnika prije 25. aprila 1974. godine, kada je uspostavljena demokratska vlast u Portugalu, koji je uvijek dolazio u školu u 8 ujutro držeći loptu, zapisao časove u dnevnik za čitav dan, poneka izlazio na kafu, a u vrijeme ručka vraćao bi se da pokupi svoju loptu. Ovo je nedvosmisleno čas fizičkog vaspitanja [...]*".

S obzirom na unutarnju podjelu časa fizičkog vaspitanja, prema ovom nastavniku čas "*mora da ima period zagrijavanja i period istezanja. Onda se obrađuje didaktička jedinica. Zabavni dio, igre i fitnes prema sadržaju moraju takođe da budu dio nastave, i na kraju vježbe istezanja i opuštanja. Samo ponekad to nije lako postići [...]*" (UR[1] 10). Iz toga proizilazi vrlo podudarna struktura koju Rodrigues (1994) smatra adekvatnom.

Nastavnik -E7- izražava razmišljanje tipično za ove nastavnike, ukazujući da on voli dobro strukturirane i planirane časove, ali je svjestan da oni trebaju biti fleksibilni, jer usvajanje krutog stava može izazvati neka ograničenja. Iz svog iskustva i znanja on navodi da: "*[...] u zavisnosti od časa, moramo da usvojimo različite strategije. Kasnije, on ističe da je često potrebno da cijenimo ulogu motivacije i sportske dinamike, gdje postoji više slobode i nastava je data u obliku igre, koja se sviđa učenicima*". Prilikom pripreme svojih časova, ovaj nastavnik voli integrisane aktivnosti. On kaže: "*[...] ako ja podučavam košarku ili odbojku, nema smisla trčkarati naokolo bez lopte. Sve aktivnosti trebaju da budu usmjerene na dotični sport i integrisane. Ako učenik mora da savlada dribling onda će se on zagrijavati sa loptom*".

Stav nastavnika -E8-, također sa ISEF-a u Portu, kada je u pitanju planiranje nastave vrlo je slična stavovima prethodnog nastavnika. On brani ideal o dobro strukturiranoj nastavi, a svjestan je da je neophodno zadovoljiti motivaciju učenika. U tom smislu, on je vrlo kritičan prema nastavnicima koji: "*[...] često se odriču unaprijed definisane strukture samo da udovolje učenicima zanemarujući važne vježbe potrebne kako bi usvojili određeni sport. To je razlog zašto ponekad učenici 12 razreda ne znaju, na primjer, kako napraviti dodavnje u lijevu stranu koristeći lijevu ruku*". S tim u vezi on zaključuje da moramo biti svjesni da: "*[...] u fizičkom vaspitanju ima puno prostora za dodatno igranje, ali tu je i vrijeme za 'ozbiljno' učenje. Sve discipline imaju ciljeve koji moraju da budu zadovoljeni, i ako je moguće postići taj cilj na zabavan način, to je u redu, ali ponekad nije lako pronaći 'igru' za sve što se radi*".

Sa istim načinom razmišljanja, nastavnik -E10-

[1]UR - Jedinica registra

Along the same line of reasoning, teacher -E10- highlights the importance of a directed class, goal--oriented and well structured. More assertive than the other teachers before, he strongly advocates a structured class oriented by the teacher, regardless of the students' motivations, because he believes that: "*[…] it is the responsibility of the teacher to find strategies to motivate students into learning a particular didactic unit. For this teacher, it is important to divide the lesson into three parts: a warm-up period at the beginning, directed to the sport being taught, and always directed and supervised by the teacher and not by the students. The warm-up issue is so specific that I cannot give them a warm-up typical of gymnastics, and then teach them volleyball, or a warm-up specific for athletics, and then teach them basketball. After the warm-up, the lesson follows along sequential stages or objectives according to the different course units, and ends with time for recreational and fun activities*". Finally, teacher -E11-, whose opinion is slightly different from the previous teachers. Unlike them, the focus is on the students' motivations, whilst affirming the need to structure the lessons. But this is definitely not the most important. The lesson is based on a three-part model starting with a: "*[…] specific warm-up for the sport in question, trying to motivate students in this phase. Then comes the most important part, in which I follow the annual plan, and then back to a calmer period, with the fitness part or the relaxation exercises*".

With regard to there being different attitudes and practices in the teaching of Physical Education, teachers trained at the ISEFs are also unanimous in considering that differences exist and are mostly the result of totally different training in the past forty years, because the Portuguese historical context has changed and each person's experiences and personalities differ. As we can see in the second record in Table 3, teacher -E7- feels that different practices exist and are mostly the result of totally different training. Moreover, he also feels that: "*[…] the different experiences, different historical contexts and different training are the main reasons behind those different attitudes*". In this respect, he ends by saying that: "*if there is only one Physical Education, the practice could also be almost exclusively one [...]*".

Teacher -E8- also stresses this idea, saying that: "*there are teachers with distinct training, who received a specific type of training, who lived in a specific historical, political and social context, with unique ideas*". Despite this heterogeneity, he is sure of one thing, that: "*[…] the teacher with no type of training whatsoever no longer exists*".

Teacher -E10-, in addition to the reasons given, adds that the cause of those differences is: "*[…] the degree of motivation and personal achievement. I don't believe that a teacher who comes to school 'bothered with his life', having driven many miles and with a precarious work contract*

naglašava važnost vođenja časa, usmjerenog na ciljeve i dobro strukturiranog. Sa više samopouzdanja od prethodnih nastavnika, on se zalaže da se nastavnik orijentiše ka strukturiranom času, bez obzira na motivaciju učenika, jer smatra da: "*[...] je odgovornost nastavnika da pronađe način da motiviše učenike na savladavanje određene didaktičke jedinice. Za ovog nastavnika, važno je da čas podijeli u tri dijela: period zagrijavanja na početku usmjeren na sport koji će se izučavati koji je uvijek rukovođen i nadziran od strane nastavnika, a ne od učenika. Pitanje zagrijavanja je toliko specifično da ja ne mogu da im dam zagrijavanje tipično za gimnastiku, a zatim ih podučavam odbojku ili zagrijavanje specifično za atletiku, a zatim ih podučavam košarku. Poslije zagrijavanja, slijedi lekcija kroz različite faze ili ciljeve u skaldu sa različitim nastavnim jedinicama, a završava se sa vremenom za rekreativne i zabavne aktivnosti*". Na kraju, nastavnik -E11-, čije mišljenje se nešto razlikuje od prethodnih nastavnika, fokus stavlja na motivaciju učenika, ali potvrđujući potrebu da se nastava strukturira. To definitivno nije najvažnije, te se po njemu nastava zasniva na trodijelnom modelu počevši sa: "*[...] specifičnim zagrijvanjem kada je u pitanju sport sa pokušajem da se učenici u ovoj fazi motivišu. Zatim dolazi najvažniji dio, u kojem se prati godišnji plan, a onda nazad u mirniji period, s fitness dijelom ili vježbama opuštanja*".

Što se tiče različitih stavova i prakse u nastavi fizičkog vaspitanja, nastavnici školovani na ISEFs-u su jednoglasni u vezi toga da postoje razlike i da su one uglavnom rezultat potpuno drugačijeg sistema obrazovanja u proteklih četrdeset godina. Razlog takvih razmišljanja je portugalski istorijski kontekst, a i iskustvo i ličnost svake osobe ponaosob. Kao što možemo vidjeti u drugom intervju u Tabeli 3, nastavnik -E7- smatra da postoje različite prakse i uglavnom su rezultat potpuno drugačije školovanja. Štaviše, on smatra da: "*[...] su različita iskustva, različit istorijski kontekst i različito školovanje glavni su razlozi koji stoje iza takvih različitih stavova*". U tom smislu, on završava tvrdeći da: "*ako postoji samo jedno fizičko vaspitanje i nastava takođe može da bude isključivo samo jedna [...]*".

Nastavnika -E8- potvrđuje tu ideju, smatrajući da: "*postoje nastavnici koji su različito školovani, koji su dobili određenu vrstu obrazovanja, koji su živjeli u specifičnim istorijskim, političkim i društvenim uslovima, sa specifičnim načinom razmišljanja*". Uprkos ovoj heterogenosti, on je siguran u jedno, a to je: "*[...] nastavnik bez tipičnog obrazovanja uopšte više ne postoji*".

Nastavnik -E10-, pored navedenih razloga, dodaje da je uzrok tih razlika: "*[...] stepen motivacije i ličnog postignuća. Ne vjerujem da će nastavnik koji dolazi u školu, a 'koji se dosađuje u životu', nakon što se vozio puno kilometara i sa nesigurnim radnim ugovorom, imati odličan učinak i biti*

will have a great performance and be motivated to motivate students".

Teacher -E11-, in turn, prefers to point out how each teacher acts and reacts, saying that initial training does not explain all the differences: "*I, for example, refuse to hand out theory tests, and others with the same initial training do it. I believe this has to do with our personality and not with initial training*".

Representations of teachers trained since the 1990s to date- FAC

With regard to the representations of teachers trained more recently, in this area we have 48 records, distributed across the themes set out above. The first question related to the characterisation of the class reveals that most of these teachers, as we can see in the example records, prefer a well planned class according to a predefined structure (Table 4).

It is interesting to note that Pereira (1999), in another study he developed on planning and thoughts of Physical Education teachers, reaches very similar conclusions, stressing that teachers without teaching experience tend to be more systematic in planning

sam motivisan da motiviše učenike".

Nastavnik -E11- voli da ukaže kako svaki nastavnik djeluje i reaguje, govoreći da se početnom obrazovanjem ne mogu objasniti sve razlike: "*Ja, na primjer, odbijam da dajem testove iz teorije, a drugi sa istom obrazovanjem, to rade. Vjerujem da to ima veze s našom ličnošću, a ne sa našim obrazovanjem*".

Izjave nastavnika školovanih tokom 1990-ih do danas - FAC

Što se tiče izjava nastavnika školovanih u novije vrijeme, tu imamo 48 intervjua definisanih po istom principu. Prvo pitanje, koje se odnosilo na karakterizaciju časa, otkriva da je većina ovih nastavnika, kao što se može vidjeti u primjeru, radije dobro planirala čas u skladu sa unaprijed definisanom strukturom (Tabela 4).

Zanimljivo je napomenuti da je Pereira (1999) u drugom istraživanju o razvijenosti planiranja i razmišljanju nastavnika fizičkog vaspitanja, došao do vrlo sličnih zaključaka, ističući da su nastavnici bez nastavnog iskustva skloniju da budu sistematičniji u planiranju

TABLE 4
Representations of teachers trained at the FACs.

TABELA 4
Izjave nastavnika obrazovanih na FACs-u.

S	Record
E6	I advocate structured classes. For me, this is fundamental, and if there was space, I would even create five levels within the same class. I would carry out a diagnosis and divide students into groups according to their development level, but unfortunately that is not possible.
E5	When these teachers started teaching, their motivations and the concept of Physical Education were also different.

Legend: **S** - Codes of interview (Kod intervjua); **Record** - Zapis; **E6** - **Ja zagovaram strukturirane časove. Za mene to je osnova i ako ima prostora ja bih čak napravio pet dijelova unutar samog časa. Ja bih izvršio dijagnostiku i podijelio učenike prema stepenu njihovih sposobnosti, ali nažalost to nije moguće**; E5 - Kada su ovi nastavnici počeli sa podučavanjem, njihova motivacija i koncept fizičkog vaspitanja takođe su bili različiti.

Physical Education lessons than teachers with experience. Moreover, for Physical Education teachers without teaching experience, the most often mentioned reason, beyond the need to structure student learning has to do with the need to reduce insecurity and uncertainty in the interactive learning.

Regarding its structure, teacher -E6- always begins his classes: "*[…] with the warm-up, which can be done in several ways, or directed to what will be taught in class. For example, if it is basketball, we can warm-up by dribbling the*

nastave fizičkog vaspitanja, od nastavnika sa iskustvom. Osim toga, nastavnici fizičkog vaspitanja bez iskustva, najčešći razlog vide u tome da se struktura obučavanja učenika radi sa potrebom da se smanji nesigurnost i neizvjesnost u interaktivnom učenju.

Što se tiče strukture časa, nastavnik -E6- uvijek počinje svoje čas: "*[...] sa zagrijavanjem, što se može učiniti na više načina ili da je usmjerena na ono što se radi na času. Na primjer, ako je to košarka, mi se možemo zagrijavati vodeći loptu, ili jednostavno trčkarati. Zatim dolazi važan dio, u*

ball, or simply running. Then comes the important part, in which you try to meet the objectives of the didactic unit you planned, and a calmer final part, so that students leave with a smile on their faces, or say that the class was 'cool'".

Teacher -E5- has an identical view regarding the need to structure the lessons and comply with the annual programme; he organises his sessions into three distinct moments, not respecting, however, the moments mentioned by other teachers in our study and already cited by Rodrigues (1994). For this teacher trained at the University of Trás-os-Montes e Alto Douro, "*the lesson always begins with a brief warm-up, which in our region (Bragança) is all the more important, because temperatures are not ideal for sports. For example, at 8.30 am is it inhuman. A sport such as volleyball is impossible to teach properly, because at that time the kids' hands are freezing and they cannot do the movements correctly. After the warm-up we have the individual technique exercises, and the final part of the lesson always ends with a game*". As we have seen, this description lacks what Ibid called the closing of the session, aiming to lower the active state of students using, for that effect, some flexibility, stretching and relaxation exercises.

Teachers -E9- and -E15-, trained at the Faculty of Sports Science and Physical Education of Porto, also defend a structured class, but always bearing in mind students' motivation. They advocate a class in which there is a certain balance between these two dimensions. The opinion of teacher -E15- is quite clear on the commitment that must exist in a class, since it: "*[…] has to follow a certain structure, predefined, but also be focused on students' motivation*". With regard to the structure of the lesson, teacher -E9- also points out three moments: "*[…] a warm-up period, directed to the practice or an initial entertaining game with lots of 'good laughs' requiring some effort. Then follows the main part of the lesson, to work on contents. And at the end, a recreational period, with games some may find too childish, but then they always have fun and want to repeat them*". Teacher -E15-, more in line with the structure defined by Ibid, highlights: "*[…] a first part set aside for the warm-up and to explain the activities, a second part dedicated to the planned activities, to develop the specific skills required by that unit, and a final part for relaxing, and sometimes a bit of aerobics*".

With regard to the existence of different attitudes and practices in the teaching of Physical Education, these teachers corroborated the opinion of teachers trained at other schools, saying that if differences do exist, they are the result of different experiences and personalities. As we can see in the second example of records, in Table 4 teacher –E5- feels that there are different attitudes, in particular of graduates from

kojem pokušavam da ispunim ciljeve didaktičke jedinice koja je planirana i na kraju mirniji, završni dio, tako da učenici napuste čas sa osmijehom na licu ili da kažu da je čas bio 'kul'".

Nastavnik -E5- ima identičan stav o potrebi strukturiranja nastave u skladu sa godišnjim programom. On organizuje svoje časove u tri različite cjeline, ne poštujući cjeline koje spominju drugi nastavnici u našem istraživanju, a što je već citirano od strane Rodriguesa (1994). Za ovog nastavnika školovanog na Univerzitetu u Trás-os-Montes e Alto Douro, "*nastava uvijek počinje sa kratki zagrijavanjem, što je u našoj regiji (Bragança) najvažnije od svega, jer temperature nisu idealne za sport. Na primjer, u 8.30 časovi su i više nego nehumani. Sport poput odbojke je nemoguće pravilno podučavati, jer u to vrijeme ruke djece su hladne i oni ne mogu pravilno da rade pokrete. Nakon zagrijavanja imamo individualne vježbe tehnike, a završni dio časa uvijek se okonča sa igrom*". Kao što vidimo u ovom opisu nedostaje ono što Ibid naziva "zatvaranje" časa, a koji ima za cilj smanjiti aktivnost učenika koristeći, u tu svrhu, određene vježbe fleksibilnosti, istezanja i opuštanja.

Nastavnici -E9- i -E15-, školovani na Fakultetu sportskih nauka i fizičkog vaspitanja u Portu, takođe brane strukturirane časove, ali uvijek imaju u vidu i motivaciju učenika. Oni zagovaraju čas u kome postoji određena ravnoteža između ove dvije dimenzije. Mišljenje nastavnika -E15- sasvim je jasno o obavezama koje moraju postojati na času, jer se: "*[...] mora pratiti određena struktura, prethodno definisana, ali treba biti i usmjeren na motivaciju učenika*". Što se tiče strukture časa, nastavnik -E9- takođe ističe tri momenta: "*[...] period zagrijavanja, usmjeren na vježbe ili početne zabavne igre sa puno 'zdravog smijeha' koji zahtijevaju određeni napor. Zatim slijedi glavni dio časa u kome se radi na sadržaju. I na kraju, rekreativni period, sa igrama od kojih neke izgledaju suviše djetinjasto, ali se učenicima uvijek zabavne i traže da ih ponovimo*". Nastavnik -E15- više je sklon strukturi časa definisanoj kod Ibid i ističe: "*[...] prvi dio odvojiti za zagrijavanje i da se objasne aktivnosti, drugi dio posvećen je planiranim aktivnostima kako bi se razvile specifične vještine koje zahtijeva ta nastavna jedinica, te završni dio za opuštanje, a ponekad i za malo aerobika".*

S obzirom na postojanje različitih stavova i prakse u nastavi fizičkog vaspitanja, ova grupa ispitanika potvrđuje mišljenje nastavnika školovanih na drugim ustanovama, govoreći da, ako razlike zaista postoje one su rezultat različitih iskustava i ličnosti. Kao što možemo vidjeti u drugom primjeru intervjua u Tabeli 4 nastavnik -E5- smatra da postoje različiti stavovi, posebno kod onih koji su diplomirali na INEF-u i ISEF-u, jer u stvarnosti, jer njihov koncept fizičkog

INEF and ISEF, because, in reality, the concept of Physical Education was rather different.

He also explains that: "*if you place someone who has graduated 20 or 30 years ago teaching next to someone who has just graduated, I have no doubt that the former will be surprised at the exercises used by the one who has just graduated*". He concludes on a critical note, "[…] *if older teachers invested more in training, the situation would be different, but because they accommodate themselves or because of inexistent training here, this is the situation*".

Teacher -E9- also stresses the different training and the personality of each teacher. In line with the previous teacher, he also mentions a certain slackness by the older teachers who: "*no longer have the patience for teaching activities. Because their training was, in general, more limited, and because their bodies also resent it, they choose not to do the practical training*".

DISCUSSION / CONCLUSION

From the analysis of the interviews, briefly presented in the previous pages, we see that some aspects are more consensual or receive greater attention than others. One of the more consensual aspects is that most Physical Education teachers believe in a well structured and outlined class, based on strict planning, not neglecting, however, the issue of students' motivation.

On the structure of the class, we conclude that most teachers divide it into three distinct moments: initial or preparatory, the body or key part of the class, and the final part or closure. The initial part of the class consists of the active part or "warm-up"; the main part of the lesson aims to achieve the operational objectives defined; and the final part aims to lower the active state of students, using for that effect some flexibility exercises and/or relaxation.

In turn, from the discussion on the different attitudes and practices in Physical Education, we conclude that teachers attribute these differences mostly to training, experiences, historical contexts, personality and their motivations, which shows a relationship between the pedagogical practices of these teachers and their habitus.

Given these perceptions, it is interesting to note that these teachers trained since the 1970s, regardless of their training school, their professional experience and their motivations, have very identical representations about what should be the pedagogical work of the Physical Education teacher, which in a way suggests the existence of union in this professional group. Note that these results are consistent with recent studies developed by Cortesão (2010), Ferreira, Martins (2010), i Moreira i Ferreira (2011), a koji

vaspitanja je bio zančajno drugačiji.

On takođe objašnjava da: "*ako postavite nekoga ko je diplomirao prije 20 ili 30 godina da podučava uz nekoga ko je upravo diplomirao, ja ne sumnjam da će onaj koji je ranije završio fakultet biti iznenađeni sa vježbama koje koriste onaj koji je upravo diplomirao*". On zaključuje kritičkom napomenom, "*[...] ako stariji nastavnici ulože više u usavršavanje, situacija će biti drugačija, ali pošto su se oni već prilogodili takvom radu kao i zbog nepostojanja dodatnog usavršavanja imamo situaciju takvu kakva jeste*".

Nastvanik -E9- ističe različito obrazovanje i ličnost svakog nastavnika. U skladu s prethodnim nastavnikom, on takođe spominje određenu opuštenost od strane starijih nastavnika koji: "*nemaju više strpljenja za nastavne aktivnosti. Zato je njihovo podučavanje uopštenije, sa više ograničenja, a zato što njihovo tijelo to više ne podnose oni biraju da ne izvode praktičnu nastavu*".

DISKUSIJA / ZAKLJUČAK

Iz analize intervjua, ukratko predstavljene na prethodnim stranicama, vidimo da u oviru nekih aspekta postoji konsenzus ili da su dobili veću pažnju od drugih. Jedan od konsenzualnijih aspekata je da većina nastavnika fizičkog vaspitanja vjeruju u dobro struktuiran i modeliran čas, zasnovan na strogom planiranju ne zanemarujući pri tom pitanje motivacije učenika.

Što se tiče strukture časa, možemo zaključiti da se većina nastavnika oprodjelila za tri različita dijela: početni ili pripremni, glavni ili ključni dio časa i završni dio ili "zatvaranje". Prvi dio časa sastoji se od aktivnog dijela ili "zagrijavanja", glavni dio časa ima za cilj da se postignu definisani operativni ciljevi, a završni dio ima za cilj smanjiti aktivnost učenika, koristeći u tu svrhu neke vježbe fleksibilnost i/ili opuštanje.

Zauzvrat, iz diskusije o različitim stavovima u praksi možemo zaključiti da nastavnici ove razlike uglavnom pripisuju svom školovanju, iskustvu, istorijskom kontekstu, ličnost i motivaciji, što pokazuje odnos između pedagoške prakse ovih nastavnika i njihovog habitusa.

Imajući u vidu ove percepcije, zanimljivo je napomenuti da ovi nastavnici obučeni od 1970-ih, bez obzira na svoje obrazovanje, profesionalno iskustvo i motivaciju, imaju vrlo identične izjave o tome šta bi trebao biti pedagoški rad nastavnika fizičkog vaspitanja. Na taj način ukazuju na postojanje jedinstva u ovoj profesionalnoj grupi. Treba imati na umu da su ovi rezultati u skladu sa posljednjim istraživanjima koje je izvršili Cortesão (2010), Ferreira i Moreira (2011), Martins (2010), i Moreira i Ferreira (2011), a koji

ra and Moreira (2011), Martins (2010), and Moreira and Ferreira (2011), who point to a cultural identity within the Physical Education group in Portugal, despite the fact that sometimes we notice some difficulties in the dialogue between these different generations.

Given these findings, is seems therefore important that Physical Education teachers continue to analyse the contexts in which their activity takes place, and continue to acquire new behaviours and formal and non-formal knowledge, in order to restructure the profession, giving rise to a Physical Education with professionals who are responsible, caring, united professional and loyal to this identity matrix.

ukazuju na kulturni identitet u okviru grupe fizičkog vaspitanja u Portugalu, uprkos činjenici da smo ponekad primijetili i neke poteškoće u dijalogu između ovih različitih generacija.

Imajući u vidu ove zaključke, čini se stoga važnim da nastavnici fizičkog vaspitanja i dalje analiziraju kontekst u kome se njihova djelatnost odvija i nastave da stiču nove navike kroz formalno i neformalno obrazovanje, kako bi restruktuirali profesiju. Time se izgrađuje fizičko vaspitanje sa nastavnicima koji su odgovorni, pažljivi, profesionalno povezani i odani ovoj matrici identiteta.

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PERCEPÇÕES DAS PRÁTICAS PEDAGÓGICAS DOS PROFESSORES DE EDUCAÇÃO FÍSICA EM PORTUGAL DESDE OS ANOS 70 DO SÉCULO XX

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A nossa prática profissional em instituições de formação de professores, tem contribuído para uma maior atenção e preocupação com questões inerentes à definição da identidade docente. Com o intuito de estudar estas questões, desenvolvemos o presente estudo, procurando investigar a forma como os professores de Educação Física em Portugal definem a sua profissão e o seu trabalho pedagógico, considerando os modelos de aula mais valorizados, os exercícios mais adequados à população escolar e as diferentes práticas e posturas existentes desde a década de setenta do século XX. Recorrendo a uma metodologia de cariz qualitativo o estudo centrou-se num grupo de quinze professores com, formações iniciais distintas da área disciplinar de Educação Física realizadas nas instituições mais marcantes de Portugal, como o Instituto Nacional de Educação Física, os Institutos Superiores de Educação Física e algumas das mais prestigiadas faculdades portuguesas desta área que emergiram no início da década de 90.

Da análise das entrevistas realizadas, verificámos que existem alguns aspectos que reúnem mais consenso ou mais atenção do que outros. Um dos aspectos mais consensuais, prende-se com o facto da maioria dos professores defenderem a existência de uma aula bastante estruturada e bem delineada, baseada

numa rigorosa planificação, não descurando, no entanto, a questão das motivações dos alunos. Sobre a estrutura da aula concluímos que a maioria dos professores a divide em três momentos distintos: parte inicial ou preparatória, parte principal ou fundamental e parte final ou encerramento. A parte inicial da sessão é composta pela parte activa ou "aquecimento", a parte principal da aula visa atingir os objectivos operacionais definidos para essa mesma aula e a parte final procura fazer regressar o estado de activação dos alunos a um nível mais baixo, utilizando para o efeito alguns exercícios de flexibilidade e/ou relaxação. Por sua vez, da abordagem que os professores fazem das diferentes posturas e diferentes práticas na Educação Física, concluímos que eles atribuem essas diferenças, principalmente, às formações, às vivências, ao contexto histórico, às personalidades e às suas motivações, o que indicia a existência de uma relação entre as práticas pedagógicas destes professores e o seu habitus.

Perante estas percepções é interessante notar que estes professores formados desde a década de 70, independentemente da sua escola de formação, da sua vivência profissional ou das suas motivações, têm representações muito idênticas acerca daquilo que deve ser o trabalho pedagógico do professor de Educação Física, o que sugere, de certa forma, a existência de união neste grupo profissional. Estes resultados acabam por ser consentâneos com os resultados de outros estudos recentes (Martins (2010; Cortesão, 2010; Moreira & Ferreira, 2011; Ferreira & Moreira, 2011) que apontam no sentido de uma cultura de identidade no seio do grupo de Educação Física em Portugal, isto apesar de, por vezes, notarmos algumas dificuldades no diálogo entre estas diferentes gerações.

Perante estas constatações, parece-nos, pois, importante que os professores de Educação Física continuem a analisar os contextos em que decorre a sua actividade e que continuem a adquirir novos comportamentos e novos saberes, formais e não formais, no sentido de se proceder à reestruturação da profissão, concebendo uma Educação Física com profissionais responsáveis, solidários, unidos e fiéis a esta matriz identitária.

Palavras-Chave: Educação Física, professores, práticas pedagógicas, formação inicial.

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IDENTITET I PRISUSTVO UČENICA MUSLIMANKI NASTAVI FIZIČKOG VASPITANJA U ENGLESKOJ

MUSLIM SCHOOLGIRLS' IDENTITY AND PARTICIPATION IN SCHOOL-BASED PHYSICAL EDUCATION IN ENGLAND

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SUMMARY

This article draws from an ethnographic case study of a group of Muslim schoolgirls at two schools in England. It examines the issues surrounding their religious and ethnic identity and whether this conflicts with participation in school-based Physical Education (PE). Social Identity Theory underpinned the study, focusing the research and interpretation of empirical data gathered over a period of twenty months, mainly by in-depth semi-structured interviews to explicate the PE experiences through employment of a qualitative methodology.

The social categories of ethnicity and religion play a key part in shaping the identity of Muslim schoolgirls. The girls perceive PE as a subject, which allows for freedoms not found elsewhere in the curriculum and they recognise the importance of physical activity. The study confirms the findings of previous research, which found that issues of kit, fasting during Ramadan and extra-curricular activities posed problems for Muslim pupils; these are features, which are especially compounded when teachers are not aware of the issues.

The findings demonstrated the exclusionary nature of traditional physical education settings. The experiences of pupils were more reliant upon the quality of individual teachers. Multi-cultural and racism-awareness courses appear to be indispensable for a better understanding of the pupils, and making them available to all teachers, regardless of their hierarchical standing, can be advantageous.

Key words: identity, Islam, muslim schoolgirls, physical education, religion.

SAŽETAK

Ovaj članak se oslanja na etnografsku studiju slučaja grupe učenica, muslimanki, u dvije škole u Engleskoj. Istraživanje razmatra pitanja vezana za njihov vjerski i etnički identitet, te da li su ti identiteti prepreka njihovom učestvovanju u nastavi fizičkog vaspitanja. Teorija socijalnog identiteta, na koju se oslanja ovo istraživanje, fokusira se na istraživanje i interpretaciju empirijskih podataka prikupljenih u razdoblju od 20 mjeseci, uglavnom detaljnih polustrukturisanih intervjua za tumačenje iskustva u nastavi fizičkog vaspitanja, uz korištenje kvalitativne metodologije.

Socijalne kategorije etničke pripadnosti i vjeroispovijesti igraju ključnu ulogu u formiranju identiteta učenica muslimanki. Djevojke doživljavaju fizičko vaspitanje kao predmet koji dopušta slobodu koje nema nigdje drugdje u nastavnom planu i programu i one prepoznaju važnost fizičke aktivnosti. Studija potvrđuje rezultate prethodnih istraživanja koja su utvrdila da pitanja opreme potrebne za nastavu fizičkog vaspitanja i vannastavne aktivnosti posebno dolaze do izražaja u toku ramazanskog posta i predstavljaju problem za učenike muslimane. To su odnosi koji postaju delikatni ako nastavnici nisu svjesni prisutnog problema.

Rezultati su pokazali potrebu odstupanja od tradicionalnih postavki u nastavi fizičkog vaspitanja. Takođe, istraživanje je naglasilo da pedagoški pristup i iskustvo nastavnika umnogome utiču na prevazilaženje problema. Poznavanje drugih kultura i religija, te uvažavanje određenih kulturnih razlika, neophodni su za nesmetan odnos između nastavnika i učenika.

Ključne riječi: identitet, Islam, učenice muslimanke, fizičko vaspitanje, religija.

INTRODUCTION

The norms and values of religion and culture are powerful forces in the lives of individuals, families and communities all over the world. Pervasive in the lived experience of being a Muslim is Islamic culture: "[...] The code of living is expressed through Islamic laws laid down in the Shari'ah. These codes imbue Islamic culture, giving meaning to the way in which Muslims make sense of their lives, behave, dress, eat and drink" (Benn, 1996, p. 6). According to Abbas (2004), in "Britain, the burgeoning interest in religion has come from both an awareness within the ethnic minority population of Islam and from its heightened international profile" (p. 27). Over the years, descendents of many of the first generation immigrants of Asian origin have gradually assimilated into British society by adapting to various British customs and traditions; nevertheless, they may wish to preserve specific characteristics of their cultural heritage. Such retention is indicative of "pluralism" (Anwar, 1985; Verma & Bagley, 1979). However, the "present is also a period in which subsequent generations of British South Asian Muslims have begun to question their parents' religious and cultural values" (Abbas, 2004, p. 28). This questioning can extend to the potential conflict that Muslim students have between their religious identity and participation in school-based Physical Education (PE). The major defining aspect of the study from which this article is drawn was identifying ways in which Muslim schoolgirls of Pakistani origin, perceived and negotiated their distinctive identities as Muslims, more specifically how religion, culture and gender might influence their participation in PE, a curriculum subject that has traditionally struggled to maintain standardisation in dress and involvement.

There are some 1.6 million Muslims living in Britain, comprising three per cent of the total population and over half (52%) of the non-Christian religious population. Islam and Muslims are thus part of the mosaic that comprises modern Britain, with half of the Muslim population being British born. There are over 400.000 Muslim pupils in school education. The faith commitments of Muslim pupils and their families encompass all aspects of everyday life and conduct, including daily life in school. It is important, therefore, that educators understand how they can respond positively to meeting the needs of Muslim pupils.

The identity of Muslims schoolgirls

At the heart of the study was the notion of identity, "a highly complex concept, which is difficult to elucidate" (Jacobson, 1998, p. 152) but Tajfel's (1978) conceptualisation of "social identity" provides a

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Religijske i kulturološke norme i vrijednosti su moćne snage u životima pojedinaca, porodica i zajednica širom svijeta. Islamska kultura preovladava u životnom iskustvu muslimana: "[...] ključ života izražava se islamskim zakonima, propisanim u šerijatu. Ti ključevi prožimaju islamsku kulturu, dajući smisao i način na koji muslimani vide smisao svog života, ponašanja, oblačenja, upražnjavanja jela i pića" (Benn, 1996, str. 6). Prema Abbasu (2004), "U Britaniji je pojačan interes za religiju proizašao i iz svijesti unutar etnički manjinske populacije islama i iz povećanog međunarodnog profila" (str. 27). Tokom godina, potomci mnogih emigranata azijskog porijekla prve generacije postupno su se asimilovali u britansko društvo, prilagođavajući se različitim britanskim običajima i tradicijama. Pa ipak, oni su željeli sačuvati i specifičnosti svog kulturnog nasljeđa. To je indikativno za "pluralizma" (Anwar, 1985; Verma i Bagley, 1979). Međutim, "prisutan je period u kojem generacije britanskih muslimana, porijeklom iz južne Azije, počinju da se bave pitanjima vjerskih i kulturnih vrijednosti svojih roditelja" (Abbas, 2004, str. 28). Ovo preispitivanje može se proširiti i na potencijalni konflikt koji učenici muslimani imaju između svog vjerskog identiteta i učešća u nastavi fizičkog vaspitanja (FV). Glavni aspekt studije iz koje je proizašao ovaj članak jeste utvrđivanje načina na koji učenice muslimanke, pakistanskog porijekla, opažaju i izražavaju svoje karakteristike muslimanskog identiteta. Tačnije kako religija, kultura i pol mogu uticati na učešće u nastavnom predmetu fizičkog vaspitanja, gdje se uvijek nastojalo da se svi učenici uključe u nastavu i da bude prepoznatljiv po jednoobraznoj opremi.

U Britaniji živi oko 1,6 miliona muslimana, koja čine tri posto ukupnog stanovništva i više od polovine (52%) nehrišćanske vjerske populacije. Islam i muslimani su tako dio mozaika od kog se sastoji moderna Britanija, sa polovinom muslimanskog stanovništva koje je rođeno u njoj. Preko 400.000 učenika muslimana je u školskom obrazovnom sistemu. Vjerska opredjeljenja učenika muslimana i njihovih porodica obuhvataju sve aspekte svakodnevnog života i ponašanja, uključujući u tu svakodnevicu i školu. Važno je, stoga, da nastavnici razumiju na koji način mogu pozitivno da odgovore na zadovoljenje potreba učenika muslimana.

Identitet učenica muslimanki

U središtu ove studije bio je pojam identiteta, "vrlo složen pojam, koji je teško objasniti" (Jacobson, 1998, str. 152), ali Tajfelova (1978) konceptualizacija "socijalnog identiteta" pruža korisnu dinamičnu početnu tačku

useful dynamic starting point for the analysis of ethnic, religious and national identities. The notion of social identity as dynamic was central to this study both because at a collective level, there appears to be inter-generational changes taking place in perceptions of nationality and ethnicity and religion within the Pakistani community, and also at the individual level, participants have "identity options" (Rex & Josephides, 1987) when referring to the situation of second generation British Asians. Certainly, because of their status as adolescent females and of their particular circumstances, as the children of immigrants, they may be more likely to feel that identity is an ambiguous and slippery concept. Social identity theory also addresses the issue of potential problems resulting from participation in two cultures. Tajfel (1978) discussed the likelihood that identification with two different groups can be problematic for identity formation in ethnic group members because of the conflicts in attitudes and values (including cultural and religious) and behaviours between their own and the majority group. Where helpful, other theoretical perspectives were called upon to increase understanding of emergent issues for example the notion of "embodiment" and "physical capita" in relation to the significance of symbolic dress forms some of the Muslim females adopted (Bourdieu, 1993, p. 21). The construction of profiles of British Muslim identity is a complex task with data suggesting a new process model of ethnic and national identity, which incorporates rootedness, differentiation, confusion and transcendence (Hutnik & Street, 2010).

The impact of Muslim female identity upon participation in school-based PE

Previous studies (Benn, 2005; Carroll & Hollinshead, 1993; Dagkas & Benn, 2006; Williams & Bedward, 2001) of participants' experiences in PE have demonstrated that it is a subject, which has the potential to give rise to a number of varied and contextualised reactions. As such, it is necessary to further question the perceived character of a subject that seemingly provides the foreground for a number of educational experiences, which could be considered as unique in comparison with the majority of other subjects. The specificities of PE, in regards to its place within curricula in comparison with other subjects, are worthy of interrogation in relation to the affects upon the children and young people. These varied affects are considered as being dependent upon the situational characteristics of the learner in context. Further, such research is consequently relevant to the understanding of how Muslim females experience the various elements of PE.

It is important to consider whether the experiences of Muslim females differ significantly from gen-

za analizu etničkih, vjerskih i nacionalnih identiteta. Pojam socijalnog identiteta kao dinamičnog je u središtu ove studije, zbog toga što na kolektivnom nivou postoje međugeneracijske promjene u percepciji nacionalne i etničke pripadnosti i vjeroispovijesti unutar pakistanske zajednice, ali i na individualnom nivou, učesnici imaju "opcije identitet" (Rex i Josephides, 1987) kada je u pitanju situacija sa drugom generacijom britanskih Azijata. Naravno, zbog adolescentskog statusa i specifičnih okolnosti u kojima se nalaze djeca emigranata, ona mogu jasnije da osjete da je identitet nejasan i "klizav" pojam. Teorija socijalnog identiteta takođe se bavi i problemima koja proizilaze iz pripadanja dvjema kulturama. Tajfel (1978) je mišljenja da postoji vjerovatnoća da poistovjećivanje sa dvije različite grupe može biti problematično za formiranje identiteta članova etničkih zajednica zbog konflikta u stavovima i vrijednostima (uključujući kulturni i vjerski) između svoje i većinske zajednice. Tamo gdje je to bilo korisno, pozivalo se na druge teorijske poglede kako bi se povećalo razumijevanje nastalih problema, na primjer shvatanje pojma "utjelovljenja" i "fizički po stanovniku" u vezi sa važnošću simboličkog oblika oblačenja, usvojenog od nekih muslimanskih žena (Bourdieu, 1993, str. 21). Izgradnja profila britanskog muslimanskog identiteta je složen zadatak pošto podaci ukazuju na jedan novi model procesa etničkog i nacionalnog identiteta, koji obuhvata ukorijenjenost, diferencijaciju, zbunjenost i transcendenciju (Hutnik i Street, 2010).

Uticaj ženskog muslimanskog identiteta na prisustvo nastavi FV

Prethodna istraživanja (Benn, 2005; Carroll i Hollinshead, 1993; Dagkas i Benn, 2006, Williams i Bedward, 2001) o iskustvu učesnika u nastavi fizičkog vaspitanja, pokazala su da je to nastavni predmet koji ima snagu da izazove niz raznovrsnih i dodatnih reakcija. Zbog toga, potrebno je dodatno ispitati percepciju obilježja nastavnog predmeta koji prividno, na prvi pogled, pruža veći broj obrazovnih iskustava, a koja se mogu smatrati jedinstvenim u poređenju s većinom drugih nastavnih predmeta. Specifičnosti nastave fizičkog vaspitanja u odnosu na mjesto u nastavnim planovima i programima i u poređenju sa drugim nastavnim predmetima, vrijedne su istraživanja koja se tiču njihovog uticaja na djecu i mlade. Ti raznovrsni uticaji zavise od situacijskih karakteristika učenika. Nadalje, takvo je istraživanje značajno za razumijevanje kako muslimanke doživljavaju različite elemente u nastavi fizičkog vaspitanja.

Važno je razmotriti da li se iskustva muslimanki bitno razlikuju od rodne nejednakosti, za koju je

der inequalities, which have been found to exist within school-based PE (Hargreaves, 1994; Lenskyj, 1990; Scraton 1992; Talbot, 1993). In promoting inclusion, the English National Curriculum reinforced the perception that PE is integral to the development of social skills that enable pupils to become members of their cultural community (Skidmore, 2004). The literature indicates that PE is rooted in the traditions of motor elitism and participation (Goodwin, 2007; Scraton 1992; Talbot, 1993). In England, as elsewhere, PE teachers are not renowned for their sensitivity to difference; they are a remarkably homogenous group (mostly white, young and non-disabled) and with a history of successful involvement in sports--related activity themselves, they often show little empathy with others less talented or motivated in their subject area, and are often resistant to equity issues (Armour & Jones, 1998).

For the Muslim female, sporting participation in school may conflict with the Islamic requirement for modesty. Carroll and Hollinshead (1993) reported that the wearing of the sports uniform caused embarrassment for both male and female students and feelings of guilt and shame were exacerbated when many of the activities were held in public places such as playgrounds and community parks. Communal showers caused severe problems even to the extent that some students absented themselves from school.

In considering how participation in PE and School Sport is influenced by Islam, it should be stated that there is no general prohibition from participation in sport for females in Islam (Lindsay, McEwan, & Knight, 1987). According to Benn (1996), Islam and PE share some common concerns, the central issue being control of the body, in time and space, in rituals, in cleanliness, in dress, in the control of diet and pursuit of a healthy body. Islamic scholars emphasize that health and fitness are equally important for both sexes and should be maintained by regular physical activity. The Muslim Council of Britain Guidance (2007) "Meeting the Needs of Muslim pupils in state schools" recognises the high importance of education in Islam and the need for all to pursue knowledge and learning. Within the document, there is much support for children's participation in a broad and balanced PE programme with regard for Islamic requirements.

"Physical education is a very important part of school life and full participation is to be encouraged, in order to develop a healthier lifestyle [...] There are some basic Islamic requirements for modesty which need to be considered in order to remove any unnecessary barriers for Muslim pupils to participate fully in physical education and swimming in particular" (Muslim Council of Britain, 2007, p. 36).

utvrđeno da postoji u okviru nastave fizičkog vaspitanja (Hargreaves, 1994; Lenskyj, 1990; Scraton 1992, Talbot, 1993). Kako bi se podstaklo uključivanje, nastavni plan i program u Engleskoj promoviše shvatanje da je fizičko vaspitanje sastavni dio razvoja društvenih vještina koje omogućavaju učenicima da postanu članovi svoje kulturne zajednice (Skidmore, 2004). Literatura pokazuje da nastava fizičkog vaspitanja ima korijene u tradiciji kretnog elitizma i učestvovanja (Goodwin, 2007; Scraton 1992, Talbot, 1993). U Engleskoj, kao i u drugim zemljama, nastavnici fizičkog vaspitanja nisu poznati po svojoj osjetljivosti na razlike. Oni su izuzetno homogena grupa (većinom bijelci, mladi i bez invaliditeta), koja uspješno učestvuje u sportskim aktivnostima. Takođe, oni često ne pokazuju saosjećanje s drugima, manje talentovanim ili motivisanim u području njihovog predmeta, a često su ravnodušni i po pitanjima jednakosti (Armour i Jones, 1998).

Muslimanke, učestvujući u sportu, mogu doći u sukob sa islamskim zahtjevom za skromnošću. Carroll i Hollinshead (1993) kažu da je nošenje sportske opreme izazivalo neprijatnost i kod učenika i kod učenica, a osjećanje krivice i stida su se pogoršali kada se većina aktivnosti provodila na javnim mjestima kao što su igrališta i parkovi. Javni tuševi prouzrokovali su ozbiljne probleme, čak do te mjere da su neki učenici neopravdano izostajali iz škole.

Kada razmatramo odnos islama prema aktivnostima na nastavi fizičkog vaspitanja i učešću u školskom sportu, treba navesti da ne postoji generalna zabrana ženama islamske vjeroispovijesti da učestvuju u sportu (Lindsay, McEwan i Knight, 1987). Prema Bennu (1996), islam i nastava fizičkog vaspitanja dijele neke zajedničke probleme, a centralno pitanje je kontrola tijela kroz vrijeme i prostor, u obredima, u čistoći, u oblačenju, u kontroli ishrane i u potrazi za zdravim tijelom. Učenici islamske vjeroispovijesti ističu da su zdravlje i fitnes podjednako važni za oba pola i da bi trebalo provoditi redovne fizičke aktivnosti. Vodič The Muslim Council of Britain (2007) "U susret potrebama muslimanskih učenika u državnim školama", prepoznaje veliki značaj obrazovanja i potrebu svih za znanjem i učenjem. U ovom vodiču, nalazi se mnogo podrške za učestvovanje djece u širokim i uravnoteženim programima fizičkog vaspitanja u skladu za islamskim zahtjevima.

"Fizičko vaspitanje je veoma važan dio života u školi i puno učestvovanje u njemu treba da se podstiče, kako bi se razvio zdravi stil života [...] Postoje neki osnovni islamski zahtjevi skromnosti koje treba uzeti u obzir kako bi se uklonile nepotrebne prepreke i da učenici muslimani u potpunosti učestvuju u fizičkom vaspitanju a posebno u plivanju" (Muslim Council of Britain, 2007, str. 36).

U Engleskoj, sva djeca školskog uzrasta imaju

In England, all children of school age have entitlement to PE within the National Curriculum. Directions of agencies such as the Muslim Education Trust recommend that Muslim children do participate, provided that Islamic requirements are met: dress, (track suits are considered acceptable,) changing and showers, (privacy is paramount and communal nudity forbidden), single sex provision after puberty, and avoidance of contact activities between sexes. The dress issue is particularly problematic for Muslim pupils in swimming. Where Islamic requirements are not met, the recommendation is that Muslim children should be exempt from PE (Sarwar, 1994). This creates a dilemma between Islamic and State education requirements. Furthermore, the available secondary school research into the experiences of Muslim adolescent girls (Carroll & Hollinshead, 1993; Clyne, 1994; Dagkas & Benn, 2006; Scraton, 1992) identified PE kit and compulsory showers as significant factors that contributed to some girls' negative perceptions and experiences of PE.

In a recent case study of schools in England in a large multi-cultural city, Benn et al. (2008) reported that problems arose when Muslim parents started withdrawing their daughters from PE lessons on religious grounds. Rhetorically, the social, political and education context is one of inclusivity and embracing of cultural diversity. For all children, there is a statutory national curriculum that includes PE, and a commitment to religious freedom and upholding of the human right to "manifest one's own religion". It is also important to note that Islamophobia and concerns about the hijab are regularly evidenced in the UK (and European) experiences of Muslim people and in media discourse (Fekete, 2008; Richardson, 2004; Runnymede Trust, 1997) .

From the so-called BASS Project (Benn et al., 2008), in relation to PE, the religiosity of some Muslim families led to preferences to embody faith in ways that were denied in the traditional systems and structures of the PE/School Sport participation environment in England. Such embodiment refers to body modesty, covering arms, legs and head, and gender segregation, considered essential to belief and to identity as Muslim women. Traditional cultural expectations in PE/School Sport systems such as mixed-sex lessons and shorts/tee-shirts were barriers to participation for these families, hence withdrawal. The problem was not with participating in physical activity but with systems and structures that denied preferences to embody faith. Good practice features were identified from some schools and shared in final guidance. Common to these were principles of flexibility, respect for personal choice, and accommoda-

pravo na fizičko vaspitanje u okviru nacionalnog programa. U uputstvima agencija, kao što je Muslim Education Trust, preporučuje se da muslimanska djeca učestvuju, pod uslovom da su ispunjeni islamski zahtjevi oblačenja, (duksevi se smatraju prihvatljivim) svlačionica i tuševa (privatnost je najvažnija, a javna golotinja je zabranjena), obezbjeđivanje jednopolnosti nakon puberteta i izbjegavanje aktivnosti u kojima postoji kontakt među polovim. Oprema za plivanje je posebno problematično pitanje za muslimanske učenike. Tamo gdje islamski zahtjevi nisu ispunjeni, preporuka je da muslimanska djeca ne treba da učestvuju u nastavi fizičkog vaspitanja (Sarwar, 1994). To stvara nedoumicu između islamskih i državnih obrazovnih zahtjeva. Osim toga, dostupna istraživanja iskustava muslimanskih adolescentkinja u srednjim školama (Carroll i Hollinshead, 1993; Clyne, 1994; Dagkas i Benn, 2006; Scraton, 1992) identifikovala su opremu za fizičko vaspitanje i obavezno tuširanje kao značajne faktore koji su doprinijeli da neke djevojke imaju negativnu percepciju i iskustvo u nastavi fizičkog vaspitanja.

U nedavnoj studiji slučaja škola u Engleskoj u velikom multikulturnom gradu, Benn i saradnici (2008) zaključili su da su problemi nastali kada su roditelji muslimanske djece počeli povlačiti svoje kćeri sa časova fizičkog vaspitanja. To povlačenje se zasniva na vjerskoj osnovi. Retorički, društveni, politički i obrazovni kontekst sastoji se od uključivanja i prihvatanja kulturne različitosti. Za svu djecu, postoji zakonski nacionalni program koji obuhvata fizičko obrazovanje, a i obavezu vjerskih sloboda i poštovanja ljudskih prava u "ispoljavanju vlastite religije". Takođe je važno napomenuti da se islamofobija i zabrinutost za hidžab redovno pokazuje u iskustvu muslimana u Velikoj Britaniji (ali i u Evropi), a i u medijima (Fekete, 2008, Richardson, 2004; Runnymede Trust, 1997).

Iz takozvanog BASS projekta (Benn i saradnici, 2008), a u vezi sa nastavom fizičkog obrazovanja, religioznost nekih muslimanskih porodica dovela je do naklonosti izražavanja vjere na način koji negira tradicionalni sistem i strukturu učešća u nastavi fizičkog obrazovanja /školskom sportu u engleskoj sredini. Takav pristup se kroz skromnost tijela, pokrivanje ruku, nogu i glave i rodne segregacije, smatra od suštinskog značaja za vjerovanje i identitet muslimanki. Tradicionalna kulturna očekivanja u sistemu nastave fizičkog obrazovanja i školskom sportu, kao što su mješoviti časovi za oba pola i kratke hlače /T-majice, jesu prepreke za učešće ovih porodica, i samim tim, one se povlače. Problem nije bio učešće u fizičkoj aktivnosti, već u sistemu i strukturi koje su negirali postavke utjelotvorenja vjere. Obilježja dobre prakse u nekim školama su publikovana i takav materijal je podijeljen zainteresovanim stranama. Zajedničko je

tion of difference, for example, including the young people in kit design. The emphasis was on making changes to be more inclusive. The most important point was giving access to participation. In the schools, least difficulties arose where parents were fully informed of expectations and strong links had been developed, often through community women-only sporting events. The Project's findings centred on increasing understanding of the issue itself and criticizing the structural barriers to participation. Most importantly, the English context of the inclusion/exclusion debate surrounding adherence to religious requirements in PE in the state education system was essential to understanding how to resolve inter-cultural tensions. Such a problem concerning requests to allow respect that arose in one English city would not have arisen in some countries, for example, where outward manifestation of belief is denied or in others where it is compulsory.

In relation to gender and PE/School Sport, one area, worthy of investigation is the significance of control over the body. Women in Islam are controlled or control themselves in terms of religious requirements through bodily discipline concerning where, when and how the body must appear in public to "embody" Islamic principles. Similarly, "sports as embodied practices are one of the arenas within which the social struggle for control over the physical body occurs" (MacClancy, 1996, p. 15). The struggle for Muslims in the arena of PE and sport then is related to conflicting tensions for control over acceptable ways of using the body. In England, due to issues of modesty, the traditional PE kit continues to be seen as problematic by many girls and young women (Benn, 1998; Kamiyole, 1993).

METHOD

The study, which involved a qualitative analytical approach, endeavoured to represent two groups of Year 11 (age 15–16 years) Muslim girls as a single case. This methodology is congruent with the fundamental epistemological and methodological characteristic that social organisations are constructed on purposeful actions of individuals as they negotiate their social roles and define status within a group. The research embraced an interpretive exploration that provided awareness and understanding of the Muslim female identity impacts upon participation in school-based PE. The emphasis in the study was on providing an understanding of the views and experiences that participants attach to the complexities that are involved in their participation in PE.

da su to principi fleksibilnosti, poštivanja ličnog izbora i kompromisa razlika, na primjer, uključivanje mladih u dizajn sportske opreme. Naglasak je na tome da budu uključeni u promjene. Najvažnije stvar je prisustvo nastavi FV. U školama, najmanje problema nastaje kada su roditelji u potpunosti informisani o onom što se očekuje i tako se razvija jaka veza, često kroz sportske događaje samo za žene u zajednici. Rezultati projekta usmjereni na povećanje razumijevanja samog problema kritikuju strukturne prepreke za prisustvu nastavi FV. Ono što je najvažnije, engleski kontekst rasprave uključivanja/isključivanja oko pridržavanja religijskih zahtjeva u nastavi fizičkog vaspitanja u sistemu državnog obrazovanja je od suštinske važnosti za shvatanje kako da se riješe međukulturalne tenzije. Takav problem u vezi zahtjeva da se omogući poštovanje, a koji je nastao u jednom engleskom gradu, ne bi se pojavila u nekim zemljama gdje su spoljne manifestacije vjerovanja uskraćene ili u drugima u kojima su obavezne.

U odnosu na pol i nastavu fizičkog vaspitanja/školski sport je jedno područje vrijedno istraživanja značaja kontrole nad tijelom. Žene u islamu su pod kontrolom ili kontrolišu sebe u pogledu vjerskih zahtjeva tjelesne discipline, a u vezi gdje, kada i kako tijelo treba da se pojavi u javnosti kako bi "otjelotvorila" islamske principe. Slično tome, "sport kao otjelotvorenje vjere je jedna od arena u kojoj se javlja društvena borba za kontrolu nad fizičkim tijelom" (MacClancy, 1996, str. 15). Nastojanje da se pridobiju muslimani za nastavu FV i sporta vezana je za suprotstavljanje tenzijama za kontrolu korištenja tijela na prihvatljiv način. U Engleskoj, zbog pitanja skromnosti, tradicionalna oprema za nastavu fizičkog vaspitanja i dalje se smatra problematičnom od strane mnogih djevojaka i mladih žena (Benn, 1998; Kamiyole, 1993).

METOD

Studija je objavljena 2011. godine, a provedena je kvalitetnim analitičkim pristupom, nastojala je da predstavi dvije grupe (dob 15–16 godina) muslimanki kao jedinstven slučaj. Ova metodologija je u skladu s osnovnim epistemološkim i metodološkim karakteristikama da su društvene organizacije stvorene za aktivnosti pojedinaca, kao što su njihovi potrebe o društvenoj ulozi i definisanju statusa unutar grupe. Istraživanje se posmatra kao interpretativno i ima za cilj da razvije uticaj svijest i razumijevanje muslimanskog ženskog identiteta za prisustvom u nastavi fizičkog vaspitanja u školi. Naglasak istraživanja bio je na pružanju razumijevanje pogleda i iskustava koje učesnici pridaju složenosti a koji su vezani za njihovo prisustvo u nastavi fizičkog vaspitanja.

Data Collection

Semi-structured interviews

For consistency with methodological issues, interviewing was considered to be the most suitable method of data collection. Data were gathered by means of in-depth interviewing, using semi-structured interview schedules. The questions initially formulated for the two interview schedules with the Muslim schoolgirls were based on the literature review and pertinent aims of the study. A number of issues were investigated including identity and school ethos. The in-depth interview is a powerful way to elicit research data. To maximise results, the researcher has to "actively listen", to keep the interview "focused", "infilling and explicating" where data is lacking and identifying clues from respondents. Furthermore, when interviewing pupils, the researcher had to demonstrate that she had the necessary qualities to engage with respondents, and yet still remain detached. Each experience was achieved through the management of impressions (Goffman, 1990), as well as through the utilisation of appropriate social science methods. It was important to conduct a pilot study prior to the main research to establish appropriate questions for the semi-structured interviews and also for the systematic observation sheets. Black's (1999) advice to avoid over-complicated questions was also useful when reviewing feedback and in ensuring that participants understood the questions. Asking about abstract concepts such as identity and school ethos was avoided as were leading questions. Where appropriate, the wording was simplified as the pilot study progressed. Due consideration was also given to politically correct language. With criticism (Marshall & Rossman, 1989) of interviewing as the sole method of data collection in mind, whilst it was the principal research method of data collection in the study, additional information was obtained through attendance registers and systematic observations of PE lessons.

Systematic Observation

In order to investigate whether Muslim female identity impacts upon participation in school-based PE, systematic classroom observation was carried out. The observation was intended to show if Muslim schoolgirls had different levels of engagement with their work and different types of interaction with their teachers than non-Muslim pupils.

Ethical considerations

Entry to the PE setting was negotiated first with the Head of Department and then with the individual staff to whom the research was outlined, both verbally and in writing. As the research also involved

Prikupljanje podataka

Polusturkturisani intervjui

U skladu sa metodološkim problemima, intervjuisanje se smatra najpodesnijom metodom prikupljanja podataka. Podaci su prikupljeni putem detaljnih intervjua, pomoću polustrukturisane liste pitanja. Pitanja za učenice muslimanke su, za početak, formulisana u dvije liste na osnovu pregleda literature i odgovarajućih ciljeva istraživanja. Istraživala su se brojna pitanja, uključujući pitanja identiteta i školske navike. Detaljan intervju je dobar način da se dođe do podataka za istraživanje. Kako bi se maksimizirali rezultati, istraživač mora da "pažljivo sluša", da "usmjerava" intervju, "doda i objasni" tamo gdje podaci nedostaju i identifikuje ono što ispitanik nagovještava. Pored toga, prilikom intervjuisanja učenica, istraživač je morao da pokaže da ima sve neophodne kvalitete da sarađuje sa ispitanicima, a da je ipak ostao neutralan. Iskustvo su stečena preko upravljanja utiscima (Goffman, 1990), kao i korištenjem odgovarajućih metoda iz društvenih nauka. Važno je bilo provesti pilot studiju prije glavnog istraživanja, kako bi se utvrdila odgovarajuća pitanja i obezbijedilo sistematsko analiziranje dobijenih podataka. Blackov (1999) savjet da bi trebalo izbjeći pretjerano komplikovana pitanja je, takođe, koristan prilikom analize povratne informacije kako bi se osiguralo da učesnici razumiju pitanja. Postavljanje pitanja o apstraktnim pojmovima kao što su identitet i školske navike treba izbjegavati jer su sugestivna. Tamo gdje je to bilo moguće, formulisanje je pojednostavljeno. S obzirom na značaj, takođe je korišten i tolerantan jezik. Uz kritički pristup (Marshall i Rossman, 1989) intervjua kao jedinstvenog naučnog metoda prikupljanja podataka istraživanja, dodatni podaci su dobijeni kroz kontrolu upisa podataka i sistematsko posmatranje časova FV.

Sistematsko posmatranje

Da bi ispitali da li muslimanski ženski identitet utiče na prisustvo u nastavi fizičkog vaspitanja, sprovedeno je sistematsko posmatranje nastave. Posmatranje je trebalo da utvrdi da li su učenice muslimanke imale različit nivo radnog angažovanja i različitu vrste interakcije sa svojim nastavnicima u odnosu na učenice nemuslimanke.

Etička pitanja

Ulazak ispitivača u prostor u kome se odvija nastava fizičkog vaspitanja je obavljen uz saglasnost načelnika odjeljenja, a zatim je obaviješteno i osoblje kome je objašnjeno istraživanje: kako usmeno tako i pismeno.

direct contact with individual children, parental and child permission was acquired. Pseudonyms were used for the schools and the pupils to ensure confidentiality.

Sampling

The groups of pupils selected were not intended to represent some part of the larger world but to offer instead an opportunity to glimpse the complicated character, organisation and logic of culture. The study was confined to a sample of ten Muslim girls in two schools in year 11; the sample actually consisted of all of the Muslim female pupils in that year group.

Geo-demographic settings of the schools

The Borough of Dudley was chosen as the area for the research. Dudley, part of the West Midlands conurbation is located south of Wolverhampton and is the largest town in the "Black" country. The city of Birmingham is located approximately 10 miles away.

School 1 – Birchincliffe School (pseudonym)

This is a slightly larger than average 11−16 comprehensive school with 1.177 pupils on the school roll. The school is non-denominational. Approximately 8% of pupils are of Muslim faith

School 2 – Chamberlain School (pseudonym)

For means of comparison, a second school, also in Dudley MBC, was selected. The school has 1.366 pupils in the age range 11−16, the majority of whom are from socially deprived areas. The total number of Muslim pupils in the school is 20.

Data Analysis

The analysis involved identification of patterns or themes arising in the data. Such identification influenced the direction of research, for example, facilitating the structuring of subsequent interviews, ordering and re-ordering of data. This involved identifying salient, grounded categories of meaning held by the participants in their particular setting (Marshall & Rossman, 2006) with a focus on discovering patterns, themes and categories in data that were not pre-determined by experimental hypotheses prior to data collection.

Preliminary analysis of information generated by the girls revealed a number of linked themes, which facilitated the formulation of broad categories. Further analysis established a consolidated set of categories, variously embracing: the shaping of identity; the importance of religion; relationships with parents and

Kako je istraživanje uključivalo direktan kontakt sa djecom, tražila se dozvola roditelja i djece. Za škole i učenike korišteni su pseudonimi kako bi se obezbijedila tajnost podataka.

Uzorak

Namjera sa odabranom grupom učenica nije bila da predstavlja neki dio šireg svijeta, već da ponuditi osvrt na složenu prirodu, organizaciju i logiku kulture. Istraživanje se ograničilo na uzorak od 10 muslimanki u dvije škole u 2011. godini. Uzorak se zapravo sastojao od grupe svih učenica muslimanski u toj godini.

Geo-demografske pozicije škola

Gradić Dudley izabran je kao područje za istraživanje. Dudley, dio regiona West Midlands, nalazi se južno od Wolverhamptona i najveći grad u "Black" zemlji. Grad Birmingham je udaljen približno 10 milja od njega.

Škola 1 – Birchincliffe School (pseudonim)

Nešto je malo veća od prosječne opšte srednje škole, za uzrast 11−16 godina, koju pohađa 1.177 učenika. U školi nema vjerske dominacije. Oko 8% učenika su islamske vjeroispovijesti.

Škola 2 – Chamberlain School (pseudonim)

Kao sredstvo poređenja izabrana je druga škola u Dudley MBC. Škola ima 1.366 učenika, uzrasta 11−16 godina, od kojih su većina iz socijalno ugroženih sredina. Ukupan broj učenika muslimana u školi je 20.

Analiza podataka

Analiza je uključivala identifikaciju uzoraka ili tema koje su se javljale u podacima. Takva identifikacija uticala je na pravac istraživanja, na primjer, olakšavala je kasnije strukturisanje intervjua, sređivanje i preuređenje podataka. To znači identifikaciju glavnih (utemeljenih) kategorija stavova koje su iznosili učesnici intervjua u okruženju kome su pripadali (Marshall i Rossman, 2006). Naglasak je bio otkrivanje modela, motiva i kategorija u podacima koji nisu unaprijed utvrđeni prije prikupljanja podataka eksperimentalnim hipotezama.

Preliminarna analiza podataka iznesenih od strane djevojaka pokazala je niz povezanih tema, što je omogućilo formulisanje širokih kategorija. Daljnja analiza ustanovila je konsolidovani skup kategorija, različitog prihvatanja: oblikovanje identiteta, važnost vjere, odnosi s roditeljima i prijateljima, napetosti između religijskih identiteta i školskog fizičkog

friends; tensions between religious identity; and school--based PE including dress code/kit issues, changing facilities and teacher understanding of Ramadan.

Findings

There were a number of noteworthy issues which were discussed in the interviews and, consequently, a number of core themes emerged, the first of which related to the identity of Muslim schoolgirls. As indicated in the earlier paragraph on ethical considerations, in the ensuing text, pseudonyms for the study's participants and their schools are provided applied to protect identity and ensure confidentiality.

Identity

The distinctive attribute of the Muslim females interviewed was not necessarily their physical appearance, although this was a significant part, but also cultural values: a collective pool of values, customs and behaviour (Verma & Ashworh, 1986) with inter--connectedness of faith, body and identity (Benn, 2009). Soraya and Laila were both indigenous, second--generation British and both described themselves as British Pakistani. Laila spoke of the English culture being also her culture and this view was shared by the majority of the girls interviewed, with the exceptions of identical twins Pardaj and Rabiya who described their ethnic identity as Pakistani Muslim without any reference to a British component. The girls defined their identity by looking at Asian and British components and adopting and adapting aspects from both cultures to construct their identity. Pardaj, Rabiya and Lafiza embodied their faith more than did the other girls in the sample. Munira (Chamberlain School), a close friend of Lafiza, chose not to wear the headscarf with her parents' approval: "

> Like she wears a scarf (pointing to Lafiza) and I don't; my Dad goes to me like it's your choice and my Mum, like if you don't wonna wear it you don't 'ave to. Well if you go to the Mosque then obviously you have to wear it.

The Islamic feature of modesty and the importance of religion were important to all of the girls in the sample as exemplified in the following quotations:

> A girl who wears a short skirt and showing too much of herself has no self respect. The school should do more to stop them, like say skirts have to be a certain length but they don't do anything (Madhia, Birchincliffe School).
> Well, yes it's my whole life! It's fasting during Ramadan, praying and reading the Qur'an. My parents sometimes have to remind me to pray but I don't mind 'cos I think it's important (Laila, Birchincliffe School).

vaspitanja, uključujući i oblačenje/pitanja opreme, promjene na objektima i shvatanje Ramazana od strane nastavnika.

Nalazi

Jedan broj pitanjima koja su razmatrana u intervjuima bio je vrijedan pažnje, a shodno tome i pojavio se jadan broj ključnih tema, od kojih je na prvom mjestu identitet učenica muslimanki. Kao što je to već prethodno navedeno pod etičkim pitanjima, u tekstu koji slijedi, primjenjuje se navođenje pseudonima za učenice učesnice i njihove škole kako bi zaštitili identitet i osigurali povjerljivost.

Identitet

Fizički izgled intrevjuisanih muslimanki nije bio predmet ispitivanja, iako je to bilo značajno, već kulturne vrijednosti: kolektivne vrijednosti, običaji i ponašanja (Verma i Ashworh, 1986) sa međupovezanošću vjere, tijela i identiteta (Benn, 2009). Soraya i Laila su druga generacija Britanki i obje sebe opisuju kao britanske Pakistanke. Laila je izjavila da je engleska kultura takođe i njena kultura. Ovo stanovište dijeli većina intervjuisanih djevojaka, s izuzetkom jednojajčanih blizankinja Pardaj i Rabiya koje su opisale svoj etnički identitet kao pakistanske muslimanke, a pri tome nisu ni jednog trenutka se pozivale na svoj britanski dio etničkog identiteta. Djevojke su definisale svoj identitet u odnosu i na azijski i britanski dio i usvojili su i prilagodile aspekte iz obje kulture izgrađujući svoj identitet. Pardaj, Rabiya i Lafiza vise su posvjećene vjeri nego ostale djevojke u uzorku. Munira (Chamberlain škola), bliska Lafizina prijateljica, odlučila je de ne nosi maramu, uz odobrenje svojih roditelja:

> Kao što ona nosi maramu (pokazujući na Lafizu), ja je ne nosim; moj tata kaže da je to moj izbor, a moja mama: ako je ne želiš nositi i ne moraš. Ali ako idete u džamiju, tada, jasno morate da je nosite.

Islamska osobina skromnosti i privrženosti vjeri je važna za sve djevojke, što se i zaključuje:

> Djevojka koja nosi kratku suknju i pokazuje se previše nema samopoštovanja. Škola treba da učiniti više da ih spriječi, kao na primjer da suknje moraju biti određene dužine, ali ona tu ne čini ništa (Madhia, Birchincliffe škola).
> Pa, da to je cijeli moj život! To je ramazanski post, molitva i čitanje Kurana. Moji roditelji ponekad moraju da me podsjete da se molim, ali nemam ništa protiv, jer mislim da je to važno (Laila, Birchincliffe škola).

According to Basit, (1995) "it is very rare for a Muslim to become a non-believer or even non-practising" (p. 281). This was confirmed in the interviews. Soraya and Laila both stressed the importance of their religion. For Laila, Islam was not just a religion but a way of life: The girls spoke of religion as a guide that tells them what to do as giving life meaning and something to live by. The girls maintained that parental pressure to pray was moderate but they did not mind being reminded to pray due to the importance of religion. The literature also describes relationships with parents and friends as an important factor in the shaping of identity. Relationships with parents were described as constructive. Safath expressed pleasure in having a harmonious relationship with her parents; she did not consider her parents as over-protective but rather she justified this as her parents being concerned for her safety and welfare. She also believed that her parents understood the situation:

> I am so happy that I get along with my parents so well I suppose it is about bonding when you are small, I mean I was really close to my Mum and my Dad and I bonded with them so well and they are both understanding parents and some parents are not like that (Safath, Birchincliffe School).

Laila also expressed a similar outlook in that her parents were concerned about her choice of clothes and she joked that they thought that she was into "Devil worship" due to the predominance of red and black clothing in her wardrobe. The majority of girls in the sample had friends who were Muslim. Rabiya (Chamberlain School) reported the ethnic solidarity of being able to feel more at ease with other Muslims because:

> [...] you can talk in our own language and just have fun you can't do that with English people, white people.

Pardaj stated that they did not "hang out" with white girls because they would prefer to spend time with friends who shared their way of life. On the other hand, Hafsa stated that she had both Muslim and non-Muslim friends with whom she would socialise in and out of school. Pardaj and Rabiya expressed a strong ethnocentric bias towards their own culture but, nevertheless, they did like the "hip hop" music and the fashion. Both Laila and Soraya had non-Muslim friends and explained that this was not problematic. Laila suggested that her friends did attempt to understand her religion and culture:

> Friends understand, or try to understand our religion and culture like they don't eat in front of me when I'm fasting and try and force me into bars [...] Getting drunk and not being able

Prema Basit, (1995) "veoma je rijetko za muslimana da postane nevjernik pa čak i da se ne moli" (str. 281). Ovo su potvrdili i intervjui. Soraya i Laila su naglasile važnost svoje religije. Za Lailu, islam nije samo religija, nego i način života: djevojke pričaju o religiji kao o vodiču koji im govori što treba da rade kao i da im daje smisao životu i kako živjeti. Djevojke su tvrdile da je roditeljski pritisak da se mole bio umjeren, ali to što ih podsjećaju da se mole njima ne smeta zbog važnosti religije. U literaturi je također opisan odnos sa roditeljima i prijateljima kao važan faktor u oblikovanju identiteta. Odnosi sa roditeljima su opisivani kao konstruktivni. Safath je izrazila zadovoljstvo što ima skladan odnos sa svojim roditeljima. Ona ne doživljava svoje roditelje kao svoju dodatnu zaštitu, već opravdava to tako što se njeni roditelji brinu za njezinu sigurnost i dobrobit. Ona također, smatra, da su njeni roditelji razumjeli situaciju:

> Toliko sam sretna što sam tako dobra sa svojim roditeljima i pretpostavljam da se radi o vezama još iz djetinjstva. Mislim da sam stvarno bliska sa mamom i tatom i da sam tako dobra sa njima da oni imaju razumjevanja prema meni za razliku od nekih drugih roditelja koji ne žele da budu tako bliski sa svojim djecom (Safath, Birchincliffe škola).

Laila je, također, izrazila sličan pogled u smislu da su njeni roditelji zabrinuti oko izbora odjeće i ona se našalila da su oni mislili da ona "obožava đavola" zbog dominacije crvene i crne odjeće u njenoj garderobi. Većina djevojaka u uzorku imale su prijatelje koji su bili muslimani. Rabiya (Chamberlain škola) je istakla etničku solidarnost kao mogućnost da se osjeća opuštenije sa drugim muslimanima zbog:

> [...] možete razgovarati na vlastitom jeziku, ili prosto se zabaviti, što ne možete uraditi sa Englezima, bijelim ljudima.

Pardaj je izjavila da se one nisu "družile" s bijelim djevojkama, jer radije provode vrijeme s prijateljicama koji dijele njihov način života. S druge strane, Hafsu je izjavila da ima prijatelje i muslimane i nemuslimane sa kojima se druži u školi i van nje. Pardaj i Rabiya izrazile su snažnu etnocentričnu pristranost prema sopstvenoj kulturi, ali, ipak, im se dopada "hip - hop" muzika i moda. Laila i Soraya imaju prijatelje nemuslimane i objašnjavaju da to nije problem. Laila je predložila svojim prijateljima da pokušaju da shvate njenu vjeru i kulturu:

> Prijatelji razumiju ili pokušavaju da razumjeti našu vjeru i kulturu na način da ne jedu ispred mene kad postim i da ne pokušavaju me prisiliti

> to remember is not my idea of a good night out (Laila, Birchincliffe School)

Although Laila expressed positive sentiments to fashion, music and dance, she did not like the permissiveness in Britain such as drunkenness. She stated:

> Yeah, like it's not my idea of having a good time if you can't remember what you did 'cos you got drunk. Most think it's cool to drink as much as you can but what's cool about that? I can't see the point.

Impact of Muslim female identity upon participation in school-based PE

The majority of the girls interviewed reported that they enjoyed PE. The notion of it being a subject where they had a "time out" from other lessons is shown in comments where girls did not think of PE in the same light as their other lessons. It meant something different to them. Munira (Chamberlain School) described how PE was a subject, which she observed as being a time and place when such enjoyment was a plausible outcome.

> I actually like PE 'cos you can do anything you like. So I like it, it's like spending you own time, like you can do sports wherever you want to. You can be sporty, there's no writing and there's no exams instead of doing writing. It's like a "doss" in some ways.

Similar opinions were expressed by Pardaj and Rabina, who both stated that they liked PE as it was a welcome break from subjects such as English where there "was too much writing". The enjoyment of lessons was further confirmed by lesson observations. The girls varied in ability and this did have some relationship to their enjoyment of lessons. The enjoyment of PE was also, dependent on the activity in question. Few girls expressed positive attitudes to weightlifting as opposed to netball or badminton. Soraya, who was a keen performer in PE and an excellent role model to her peers, reported positive attitudes to PE, but she drew the line at weightlifting!

In all cases there were a number of key factors that caused tensions for the girls' religious identity. These related to kit, changing facilities, Ramadan and teacher understanding.

Kit Issues

The Islamic concern for modesty was also an issue, which permeated the interview responses at both sample schools. The PE dress code is an important dimension because of this Islamic requirement. Both schools had adopted a kit policy where Muslim stu-

> da uđem u bar [...] Napijanje i ne biti u mogućnosti da se sjetiš bilo čega i nije moje viđenje dobrog noćnog provod. (Laila, Birchincliffe škola).

Iako je Laila izrazila pozitivno mišljenje o modi, muzici i plesu, njoj se ne sviđa popustljivost prema pijanstvu u Velikoj Britaniji. Ona je izjavila:

> Da, to nije moj način dobrog provoda, kad se ne možete sjetiti šta ste radili jer ste bili pijani. Većina misle da je kul piti onoliko koliko možeš, ali što je kul u tome? Ne vidim poentu u tome.

Uticaj muslimanskog ženskog identiteta na učešće u nastavi FV

Većina intervjuisanih djevojaka izjavila je da su uživale u nastavi fizičkog vaspitanja. Mišljenje je da je to predmet gdje imate "pauzu" od drugih časova i djevojke nisu vidjele fizičko vaspitanje u istom svjetlu kao ostale časove. Za njih fizičko vaspitanje znači nešto drugo. Munira (Chamberlain škola) je opisala da predmet fizičko vaspitanje posmatra kao vrijeme i mjesto kad je takav užitak prihvatljiv.

> Ja stvarno volim nastavu fizičkog vaspitanja zato što možete uraditi sve što vam se sviđa. Zato mi se sviđa, to je kao da provodite slobodno vrijeme, kao da se bavite sportom gdje god želite. Možete se baviti sportom umjesto da pišete, nema pisanja i nema ispita. To je kao, na neki način, da idete na "spavanje".

Slično mišljenje su izrazile Pardaj i Rabina, koji su izjavile da su voljele fizičko vaspitanje kao dobrodošao predah od predmeta kao što je engleski, gdje "ima previše pisanja". Ovo uživanje na času dodatno je potvrdila i njegova opservacija. Djevojke su varirale u sposobnostima i to je imalo neke veze sa njihovim uživanjem u časovima. Uživanje u času fizičkog vaspitanja je, takođe, zavisilo od toga koja je aktivnost u pitanju. Nekoliko djevojaka je izrazio pozitivan stav o dizanju tegova u odnosu na netbal ili badminton. Soraya, koja je bila oduševljena nastavom fizičkog vaspitanja i koja je bila izvanredan uzor svojim vršnjacima, izrazila je pozitivan stav prema ovom nastavnom predmetu, ali je skrenula pažnju na dizanje tegova!

U svim slučajevima bilo je nekoliko ključnih faktora koji su prouzrokovali tenzije u odnosu na vjerski identitet djevojaka. To se odnosi na opremu, svlačionice, Ramazan i razumijevanje od strane nastavnika.

Pitanja opreme

Odgovori u intervjuu u oba školska uzorka su prožeti islamskom brigom za skromnost. Zbog ovog islamskog zahtjeva važna stvar za nastavni predmet fizičkog vaspitanja je oprema. Obje škole usvojile su politiku opreme po kojoj učenice muslimanke mogu

dents could wear track suit bottoms in the summer and winter. The girls appreciated this as they did not want to show their legs anyway. They felt more conscious in the summer months when their non-Muslim counterparts had to wear shorts. Madhia and Safath from Birchincliffe School stated that the school should introduce a standard track suit bottoms as part of the PE kit. However, the kit policy at Chamberlain school was about to change as the new Head of PE was due to implement a new shorts for all policy purely for aesthetic reasons.

Changing facilities

Privacy is paramount to Muslim pupils. The changing facilities at Birchincliffe and Chamberlain School were both open plan and all of the girls in the study reported changing in the toilets either on a regular basis, or for every session. Munira and Laila were the only girls who stated that they frequently changed in the communal area. Hafsa described her friend Iffat who did not participate in PE due to issues of modesty.

> Iffat doesn't like doin' PE 'cos she wears that Scarf on her head and every Friday she (doesn't), like come to school.

Showering was not a salient issue as showers were no longer compulsory due to timetable constraints.

Ramadan

Religion is important in the lives of the girls in the sample and is not just confined to belief. The comments of the girls in this research show that they always fast during Ramadan. It was necessary to explore if they found it difficult to practise their religion as well as participate in PE.

At Birchincliffe School, the girls were expected to participate in some way in PE and this was exacerbated by "Athletics" occurring during Ramadan at the time the research was carried out. At Chamberlain School the girls' comments indicated that they did not participate in PE during Ramadan.

> When it's Ramadan, we don't participate in PE. We can just sit there and watch everyone or we can just do some coursework, go into another class and do something (Lafiza, Chamberlain School).
> We can just sit there and watch everyone or we can just do some coursework, go into another class and do something (Hafsa, Chamberlain School).

Also there was an onus on the students to approach the teacher during Ramadan to excuse themselves from the activity:

da nose donji dio trenerke i ljeti i zimi. Djevojke su to poštovale jer ni u kom slučaju nisu željele pokazati svoje noge. Toga su bile svjesnije u ljetnim mjesecima kad su njihove koleginice nemuslimanke morale nositi šorceve. Madhia i Safath iz Birchincliffe škole izjavile su da škole treba da uvedu standard donjeg dijela trenerke kao dijela opreme za fizičko vaspitanje. Ipak, propisi opreme koja se nosi na časovima FV u Chamberlainea školi treba da pretrpi izmjene. Novi šef FV uvodi nove propise oko nošenja šorceva, a to se radi iz čisto estetskih razloga.

Svlačionice

Privatnost je najvažnija učenicama muslimankama. Garderobni prostori u obje škole bili su i projektovani kao otvoreni. Sve učenice u istraživanju govorile su o promjenama u toaletima svake godine. Munira i Laila bile su jedine djevojke koje su prijavile često promjene u javnim prostorijama. Hafsa je opisala svoju prijateljicu Iffat koja nije učestvovala u nastavi fizičkog vaspitanja zbog pitanja skromnosti.

> Iffat ne voli fizičko vaspitanje zato što ona nosi maramu i svakog petka ona (ne)voli da dolazi u školu.

Tuširanje nije bitan problem zbog toga što ono više nije obavezno, zbog ograničenja vremenskog rasporeda časova.

Ramazan

U uzorku djevojaka religija igra važnu ulogu i nije ograničena samo na vjerovanje. Komentari djevojaka u ovom istraživanju pokazuju da se vjerovanje uvijek učvršćuje tokom Ramazana. Bilo je neophodno da se istraži da li je bilo teško da se ispovijeda svoja vjera i učestvuje u nastavi fizičkog vaspitanja.

U Birchincliffe školi od djevojaka se očekivalo da na neki način učestvuju u nastavi FV i došlo je do pogoršanja u sportskim aktivnostima tokom Ramazana u vrijeme kada je istraživanje provedeno. Izjave djevojaka u Chamberlainea školi ukazuju da nisu učestvovale u nastavi fizičkog vaspitanja za vrijeme ramazanskog posta.

> Kada je Ramazan mi ne učestvujemo u nastavi fizičkog vaspitanja. Možete samo da sjedite i sve gledate ili možemo organizovati neke kurseve, otići na drugi čas i raditi nešto (Lafiza, Chamberlain škola).
> Možemo samo tamo sjedjeti i sve gledati ili sami možemo organizovati neke kurseve, ići na druge časove i nešto raditi (Hafsu, Chamberlain škola).

Takođe tu je i obaveza učenica da se obrate nastavniku, i da opravdaju izostanak tokom ramazanskog posta:

They let us sit out (Rabiya, Chamberlain School) […] but you have to ask (Pardaj, Chamberlain School);
They know that's it's Ramadan, but we tell 'em, before we do PE like (Hafsa, Chamberlain School).

The responses to pupils from both Birchincliffe and Chamberlain Schools indicated that teachers varied in their approach to Ramadan. This is exemplified in Safath's comment:

I like the way Miss Blanchard is when you are fasting; she will be understanding, whereas some will shout "why ain't you doing it?"; she will come up to us privately and ask if we are OK and will help give us things to do, which are OK whereas other teachers they say you've got to do it; they don't understand that we can get thirsty and we can't drink so times it is a bit hot and it is a bit hard to do PE when they are being sarcastic to us.

Pardaj (Chamberlain School) also stated that teachers varied in their approach to Ramadan:

Some teachers they are strict and others are alright about it, it varies you know.

Madhia (Birchincliffe School), in contrast, believed that teachers did understand but added another dimension:

I think they do understand why we fast, er [...] but I think they just don't care personally I don't think it is a consideration.

As the research progressed the girls did make some suggestions of how they believed the teachers could adopt a more uniform approach to Ramadan.

Well it's all about them learning if they want to. They do know I know most of the teachers know and quite a lot of pupils will know they just don't take it into consideration that's it (Madhia, Birchincliffe School).
I think we should be able to miss PE when Ramadan is on because I feel tired. It is only for one month and we should be given the choice to sit out. We can sit out for one lesson but we should be able to sit out when we are fasting 'cos I just get really tired. I mean Ramadan lasts for one month so it would mean er six lessons. We should be given the choice to sit out, I am not making an excuse. It is only for six lessons (Abia, Birchincliffe School).

Some of the girls were also conscious of other pupils' reactions to their lack of participation during

Pustili su nas da sjedimo (Rabiya, Chamberlain škola) [...] ali smo morali pitati (Pardaj, Chamberlain škola).
Oni znaju da je Ramazan, ali ćemo im reći, prije nego što počne čas fizičkog vaspitanja (Hafsa, Chamberlain škola).

Odgovori učenica iz obje škole, Birchincliffe i Chamberlain, pokazali su da se stavovi nastavnika znatno razlikuju kada je u pitanju ramazanski post i nastava fizičkog vaspitanja. To je najjasnije na primjeru Safathovljevog komentara:

Dopada mi se pristup gospođice Blanchard u vrijeme posta; ona je puna razumijevanja, a neki će vikati "zašto ne radite?"; ona će nam nasamo prići i pitati da li smo OK i pomoći će nam dajući nam stvari koje treba da uradimo, koje su u redu, dok drugi nastavnici kažu moraš to uraditi; oni ne shvataju da možemo biti žedne jer je često tako vruće a ne možemo piti i malo je teško raditi fizičko kad su drugi sarkastični prema nama.

Pardaj (Chamberlain škola) takođe navodi da se nastavnici razlikuju u fizičkim aktivnostima tokom ramazanskog posta:

Neki nastavnici su strogi, a drugi su u redu. U vezi sa tim, znate, postoje razlike.

Madhia (Birchincliffe škola), suprotno tome, vjeruje da je nastavnici nisu razumjeli, ali dodaje jednu novu dimenziju:

Mislim da oni ipak razumiju zašto postimo, hmm [...] ali mislim da ih jednostavno to lično ne interesuje i lično ne mislim da ih je briga.

Kako je istraživanje napredovalo, djevojke su napravile neke prijedloge, i smatraju da nastavnici mogu usvojiti jedinstveni stav kada je u pitanju nastava fizičkog vaspitanja i ramazanski post:

Sve je do njih da nauče ako to žele. Oni to znaju, i ja znam da većina nastavnika to zna, i prilično učenika zna, samo što oni to ne uzimaju u obzir (Madhia, Birchincliffe škola).
Mislim da bismo trebali biti u mogućnosti da propustimo časove fizičkog vaspitanja za vrijeme Ramazana, jer se osjećam umorno. To je samo jedan mjesec i trebali bi nam dati izbor da sjedimo sa strane. Mi možemo učestvovati u času, ali trebali bismo biti u mogućnosti da sjedimo sa strane u vrijeme posta zato što smo jako umorni. Znate, Ramazan traje mjesec dana, pa to bi značilo šest časova. Trebao bi se dati izbor: da se sjedi sa strane, ja neću da se pravdam. To je samo šest časova (Abija, Birchincliffe škola).

Neke od djevojaka takođe su bile svjesne reakcija drugih učenika na njihov izostajanje sa nastave fizičkog

Ramadan and believed that the teachers could do more to raise their own levels of awareness and those of other pupils. The incidence of victimisation by teachers and other pupils was not universally shared but it did cause concern to some of the pupils as did the perceived lack of concern by the teachers.

Safath (Birchincliffe School) reported an incident, which had occurred during Ramadan:

> Yes we get comments like you don't need to sit in the sun you are already tanned and do we all eat chipates? The boys say the things to your face the girls say it behind your back. One of the popular boys asked me about the chipates and although the teacher warned him it still happened again

Madhia's (Birchincliffe School) comment indicated her frustration at the incidents of victimisation coupled with a laissez-faire approach from the teachers:

> We talk to the teachers ourselves but sometimes the teachers they don't really care, like they don't do really nothing about it and so I just think I might as well leave it 'cos there's no point wasting your time 'cos they don't really do nothing about it. If it's still going to carry on then we might as well put up with it. Nothing much happened, you can report it but it don't really change anything.

Lafiza stated that the non-Muslim girls resented their lack of participation because some of their non-Muslim counterparts also wanted to opt out of PE but for non-religious reasons.

> Some of the other girls they don't like it because they don't want to do PE either (Lafiza, Chamberlain School).
> They say it's not fair and then they will stare or talk about us behind our backs (Pardaj, Chamberlain School).

DISCUSSION

Muslim girls have been stereotypically represented as passive victims of oppressive, patriarchal home cultures (Ramji, 2003). The discourse of cultural pathology positions Asian Muslim femininities as inherently troubled and problematic (Shain, 2002). The evidence from views of Muslim girls' own accounts of their identities and lives demonstrates far from being passive cultural "victims". Muslim schoolgirls in the present study emphasised that they had happy home lives in which they enjoyed parental support for a wide range of personal, social and educational choices. This supports research by Archer (2002; 2005)

vaspitanja za vrijeme Ramazana i vjeruju da bi nastavnici mogli učiniti više u podizanje vlastite svijesti, ali i svijesti kod ostalih učenika. Pojava zlostavljanja od strane nastavnika i drugih učenika nije opšta pojava. Ali, ne postoje ni aktivnosti, niti dobra volja da se jasno ukaže na ovaj problem.

Safath (Birchincliffe škola) prijavila je incident do kojeg je došlo tokom Ramazana:

> Da, dobijamo komentare: kao da ne treba da sjedimo na suncu jer smo već preplanule i da li sve jedemo ljepine? Momci vam stvari kažu u lice, a djevojke pričaju iza leđa. Jedan od popularnih momaka me je pitao o ljepinama. Iako ga je nastavnik upozorio, to je ponovo uradio.

Madhiin (Birchincliffe škola) komentar ukazao je na frustraciju u vezi sa incidentom zastrašivanja i nezainteresovanim pristupom nastavnika:

> Razgovarale smo sa nastavnicima o nama, ali ponekad nastavnicima nije stvarno stalo, pošto oni ne rade baš ništa povodom toga i tako sam pomišljala da se manem toga pošto nema smisla gubiti vrijeme zato što oni stvarno ne čine ništa povodom toga. Ukoliko se, ipak, desi da nastavimo, onda se moramo naučiti da živimo sa tim. Ništa veliko se nije dogodilo, možete ga prijaviti, ali to zapravo ništa ne mijenja.

Lafiza je navela da su djevojke nemuslimanke nezadovoljne njihovim neučestvovanjem, pošto su neke od njihovih koleginica nemuslimanski takođe htjele da izostaju sa časova fizičkog vaspitanja, ali ne iz vjerskih razloga.

> Nekima od ostalih djevojaka se ne sviđa to jer one takođe ne žele učestvovati u aktivnostima na časovima fizičkog vaspitanja (Lafiza, Chamberlain škola).
> Kažu da to nije u redu, a onda će se zagledati u nas, ili pričati o nama iza leđa (Pardaj, Chamberlain škola)

DISKUSIJA

Muslimanske djevojke se stereotipno predstavljaju kao pasivne žrtve opresivne, patrijarhalne kućne kulture (Ramji, 2003). Kulturna patologija azijske muslimanke stavlja u nasljedno tešku i problematičnu poziciju (Shain, 2002). Dokazi iz stavova djevojaka muslimanki koje objašnjavaju svoje vlastite identitete i živote, pokazuje da su daleko od toga da budu pasivne kulturne "žrtve". Učenice muslimanke u ovom istraživanju su naglasile da su imale sreću da žive u u porodici u kojoj su uživali roditeljsku podršku sa širokim rasponom ličnih, društvenih i obrazovnih izbora. To podržava

and Basit (1997). The girls also adopted distinctly hybrid, British/English Muslim identities, arguing that they defined themselves both by their nationality/country of birth (English/British) and their religious identity the girls felt that these two identities were inextricably linked British. The majority of girls in the present study's sample was either born, or had come to live, in their infancy in the West Midlands Region of England meaning that the girls, who were in year 11 at Secondary School, had received all their schooling in Britain. Most of the girls in the sample perceived themselves as both British and Asian, epitomized, for example, in Lafiza's reference to her British status:

> We were born in this country and we were raised here and so we see ourselves as British (Lafiza, Chamberlain School).

These findings challenge the popular assumption that Muslim girls suffer from what is called "culture conflict" as a result of being caught "between two worlds". Ramji (2003), for example, argues against the popular notion that Asian women are oppressed and damaged due to having to negotiate between two opposing worlds of home and school and she criticizes the idea that Asian women lack choice and freedom in their lives. Nevertheless, ethnic minorities make their own decisions about which features of their culture of origin they want to retain and which ones they want to abandon. Similarly they embrace specific characteristics of the majority culture of their adopted country and reject others. The latter include the dress code in school and leisure activities such as the culture of drinking alcohol and its subsequent effect on behaviour, which is seen in a negative light. Thus, they create their own cultural identity by means of a process of analysis and synthesis, which is not always based on rational judgement. While many cultural traits are adopted or abandoned because of their relative usefulness or obsolescence, others are preserved merely because the minority groups like these customs and perceive them as an essential part of their cultural identity. Most girls in the study's sample admitted that they liked almost everything pertaining to the Asian way of life. The likeable features mentioned by some were: adherence to Islam; dress code; arranged marriage; and the way weddings and festivals were celebrated. The respect and closeness within the family were seen by almost all the girls as a positive aspect of Asian culture.

The girls do not choose an identity independently of their parents. They know the boundaries and respect the limits imposed by the parents. Issues, which emerged from the girls' responses, related to the relationship structures with parents together with secondary issues concerning dress codes. There were no signs of stress apparent during the interviews or

Archerova (2002, 2005) i Basitova (1997) istraživanja. Djevojke su također usvojile izrazito miješani britansko/engleski muslimanski identitet, definišući sebe i po svojoj nacionalnosti/zemlji rođenja (Engleska/Britanija) i svom vjerskom identitetu. Osjećaju da su ta dva identiteta neraskidivo britanski povezana. Većina djevojaka u uzorku ovog istraživanja je rođena, ili je u svom ranom djetinstvu došla živjeti u englesku regiju West Midlands što znači da su djevojke, koji su u 2011. godini bili u srednjoj školi, sve svoje obrazovanje dobile u Britaniji. Većina djevojaka u uzorku sebe vidi i kao Britanke i kao Azijatkinje, sažeto, na primjer, u Lafizinom odnosu prema svom britanskom statusu:

> Rođene smo u ovoj zemlji i ovdje smo odrasle tako da mi sebe vidimo kao Britanke (Lafiza, Chamberlain škola).

Ovi rezultati osporavaju ustaljenu predrasudu da djevojke muslimanke pate od onoga što se zove "sukob kultura", kao posljedice da se nalaze "između dva svijeta". Ramji (2003), na primjer, suprotstavlja se ustaljenom shvatanju da su azijske žene ugnjetavane i da im je naređeno time što moraju da se nalaze između dva suprotstavljena svjeta: kuće i škole. Ona kritikuje mišljenje da azijskim ženama nedostaje izbor i sloboda u njihovim životima. Ipak, etničke manjine donose sopstvene odluke o tome koje karakteristike svog kulturnog porijekla žele da zadrže, a koje žele da napuste. Slično tome, one prihvataju specifičnosti većinske kulture u svojoj novoj zemlji, a odbacuju ostale. To drugo uključuje principe oblačenja u školskim i slobodnim aktivnostima kao što su navika konzumiranja alkohola i njegov naknadni uticaj na ponašanje što se vidi u negativnom svjetlu. Tako one stvaraju svoj sopstveni kulturni identitet kroz proces analize i sinteze, a koja se uvijek ne temelji na racionalnom prosuđivanju. Dok su mnoge karakteristike kulture usvojene ili odbačene zbog njihove relativne korisnosti ili zastarjelosti, ostale su sačuvane jer manjinske grupe takve običaje vide kao bitan dio svog kulturnog identiteta. Većina djevojaka iz uzorka istraživanja priznala je da im se dopada skoro sve što se odnosi na azijski način života. U dopadljive osobine navedene su: poštivanje islama, pravila oblačenja, ugovoreni brak i način na koji se proslavljaju svadbe. Poštovanje i bliskost u porodici skoro sve djevojke su vidjele kao pozitivan aspekt azijske kulture.

Djevojke ne biraju identitet nezavisno od svojih roditelja. One znaju granice i poštuju ograničenja postavljena od strane roditelja. Problemi koji su se pojavili u odgovorima djevojaka odnose se na izgradnju odnosa sa roditeljima, zajedno sa sekundarnim pitanjima koja se tiču pravila oblačenja. Nije bilo nikakvih

responses leaving an impression of identity being shaped consentfully. Hafsa illustrated that although there were "rules", she did not consider them as unreasonable.

Peers are an important feature of a child's school experience (Lomax, 1978). It is clear that an important factor influencing the friendship patterns of the Muslim girls in the sample is the similitude of circumstances, mores and values. Newcomb (1961) found that the most stable friendships developed formed between those who shared similar backgrounds. Similar others will serve to validate their beliefs and increase the possibility of engaging in similar activities (Rubin, 1973). The Muslim girls have been socialized to live their lives in a particular way. They, therefore, refrain from indulging in similar pastimes as their non-Muslim peers and their contact with them is confined to the safe environment of the school.

Religion plays an important part in most British Asian communities and guides the principles around which they live. Sharpe (1976) argues that their religious beliefs and principles determine their moral ethics and form the social milieu in which they live into one centred around many stern requisites of behaviour. Such requisites include moral conformity, loyalty and cooperation, self-discipline, recognition of the dominant authority of the elders, respect for marriage and the advocation of modesty and restraint. However, these principles are confronted by the ethos of a capitalist and largely secular British society that impinges on the beliefs of these religious minorities, thus exerting pressure on them to adapt to the majority view.

Still, there may well be an enormous gap between religious beliefs, religious behaviour and religious prejudices (Delamont, 1980). People may believe in the teachings of a certain religion, though not practise it fully in their everyday lives. This is particularly true of British Muslims, the majority of whom originate from South Asia. However, there is a unique concept of religion embedded in Islam, which makes it a way of life. Consequently, etiquette and belief are closely connected and Muslims are required by their religion to live their life according to its teachings.

The majority of girls featured in this study showed a certain pride in being Muslim and referred to themselves as Muslims.

> I'm Muslim and I'm proud to be what I am. I like the way we follow it in our family (Laila, Birchincliffe School).

When asked why religion was important, Hafsa (Chamberlain School) gave the succinct answer:

> It's cos we're Muslims.

Furthermore, when the girls were asked what they thought of religion, the vast majority of them saw it

znakova očiglednog stresa tokom intervjua, ili odgovora koji ostavljaju utisak svjesno oblikovanog identiteta. Hafsu to ilustruje tako da iako je bilo "pravila", ona ih nije smatrala nerazumnima.

Uloga vršnjaka je svakako važna u odrastanju svakog djeteta (Lomax, 1978). Očigledno da je važan faktor koji utiče na modele prijateljstva djevojaka muslimanki koje su učestvovale u uzorku sličnost okolnosti, običaja i vrijednosti. Newcomb (1961) je utvrdio da su najstabilnija prijateljstva formirana između onih koji dijele slično porijeklo. Sličnost će drugima poslužiti za provjeru vlastitih uvjerenja i povećati mogućnost angažovanja u sličnim djelatnostima (Rubin, 1973). Djevojke muslimanke su socijalizovane da žive svoje živote na određeni način. One, dakle, ne učestvuju u zabavama u kojima učestvuju njihovi nemuslimanski vršnjaci, a njihov kontakt s njima je ograničen na sigurno okruženje škole.

Religija igra važnu ulogu u većini britanskih azijskih zajednica i vodeći je princip po kome njihovi pripadnici žive. Sharpe (1976) tvrdi da njihova vjerska uvjerenja i načela određuju njihovu moralnu etiku i čine društveni milje u kojem oni žive centralizovanim oko mnogih strogih načina ponašanja. Ti načini obuhvataju moralnu usaglašenost, lojalnost i saradnju, samodisciplinu, priznavanje dominantnog autoriteta odraslih, poštovanje braka i zagovaranje skromnosti i uzdržanost. Međutim, ovi principi su u suprotnosti se kapitalističkim običajima i pretežno sekularnim britanskim društvom koje ugrožava vjerovanja ovih vjerskih manjina čime se vrše pritisak na njih da se prilagode mišljenju većine.

Ipak, možda će postojati ogroman jaz između vjerskih uvjerenja, vjerskog ponašanja i vjerskih predrasuda (Delamont, 1980). Ljudi mogu da vjeruju u učenja određene religije, iako ga ne praktikuju u potpunosti u svakodnevnom životu. To posebno vrijedi za britanske muslimane, od kojih većina potiče iz Južne Azije. Međutim, postoji jedinstveni koncept religije ugrađen u islam, što ga čini načinom života. Shodno tome, pravila ponašanja i vjerovanja usko su povezana i muslimani, pridržavajući se svoje religije, žive svoj život u skladu sa njenim učenjima.

Većina djevojaka iz ove studije pokazala je određeni ponos zbog toga što su muslimanke.

> Ja sam muslimanka i ponosna sam na ono što jesam. Sviđa mi se način na koji ga slijedimo u našoj porodici (Laila, Birchincliffe škola).

Na pitanje zašto je religija bila važna, Hafsa (Chamberlain škola) je sažeto odgovorila:

> To je zato što sam muslimanka.

Osim toga, kad su djevojke pitane što misle o religiji, ogromna većina njih ju je vidjela kao vodič i

as a guide and a set of rules to live by, thus equating it with morality: Madhia perceived religion as something which gave her identity and a sense of belonging. However, the religiosity of the girls was not just confined to belief. As far as religious practice was concerned, most of them prayed and read the Qur'an occasionally, but fasted regularly, since the entire family fasted during the month of Ramadan.

The centrality of the body in PE makes the subject distinctive in curriculum studies and consequently demands heightened need for teacher sensitivity and awareness of culturally diverse embodied values (Evans, Davies, & Wright, 2004; Kirk, MecDonald, & O'Sullivan, 2006; Wright, MacDonald, & Burrows, 2004). Attention to the concept of embodiment of a physical identity acknowledges the material, physical, biological as well as the social whole of the "lived body" (Garrett, 2004, p. 141). What has been underdeveloped in current debate is any sense of the spiritual self, for example of religious identity and the struggles of people in different faiths for the basic human right to "manifest one's religion or beliefs" (Human Rights Act, 1998). In terms of research that focuses on the body and inequality, PE "as the one subject area where embodiment is fundamental and central to success and attainment", has often been ignored or marginalised in broader debates about difference and education (Flintoff, Fitzgerald, & Saraton, 2008, p. 74). Therefore, attention to embodiment, faith and PE could help to increase understanding for more inclusive practice. The concept gives meaning to the interconnectedness of faith, body and identity (Benn, 2009).

Understanding the notion of embodied faith offers insight into the core significance religion can have on life experience. It is particularly helpful in enabling those outside the faith to understand the lives of Muslim people more fully. For some Muslim people, private and internalised embodiment of faith is their choice, for others the adoption of hijab and more public manifestation of religious belief is central to their religious identity.

Where school PE or sport environments challenge the right of Muslim women to embody their faith, the result is inevitably non-participation, negotiation or coercion. Dominant western school and sport models have developed in the context of perceptions of body cultures and social interaction patterns that are not shared globally. Those who pursue freedom to maintain outward manifestation of "embodied faith", often as diaspora communities in non-Islamic countries, seek accommodation of difference as minorities in a predominantly secular society.

The study illustrated diversity in Muslim young people's preferences for degree of adherence of Isskup životnih pravila, čim ju je izjednačila sa moralom: Madhia doživljava vjeru kao nešto što je dio njenog identiteta i osjećaja pripadnosti. Međutim, religioznost kod djevojaka nije samo ograničena na vjerovanje. Što se tiče praktikovanja vjere, većina njih se moli i povremeno čita Kuran, ali redovno posti, jer cijela porodica posti tokom mjeseca Ramazana.

Činjenica da je akcenat stavljen na tijelo fizičko vaspitanje čini predmetom sa prepoznatljivim nastavnim planom i programom, a time se i zahtijeva potreba osjetljivosti i svijesti nastavnika o kulturno različitim vrijednostima vjerovanja (Evans, Davies i Wright, 2004; Kirk, MecDonald i O'Sullivan, 2006; Wright, MacDonald i Burrows, 2004). Pažnja na konceptu otjelotvorenja fizičkog identiteta priznaje "živo tijelo" kao materijalnu, fizičku, biološku i društvenu cjelinu (Garrett, 2004, str. 141). Ono što je nedovoljno jasno u aktuelnoj raspravi je osjećaj duhovnog sebe, na primjer vjerskog identiteta i borbe ljudi u različitim vjerama za osnovno ljudsko pravo do "ispolji svoju vjeru ili uvjerenja" (Human Rights Act, 1998). U odnosu na istraživanje koje se fokusira na tijelo i nejednakost, fizičko vaspitanje "kao jedno predmetno područje, gdje je otjelotvorenje osnova i središte uspjeha i postignuća", često je zanemarivan ili marginalizovan u širim raspravama o različitosti i obrazovanju (Flintoff, Fitzgerald i Saraton, 2008, str. 74). Dakle, pažnja na vjerovanje, relegiju i FV može da pomogne da se poveća razumijevanje za veće uključivanje prakse. Pojam daje smisao međusobne povezanosti vjere, tijela i identiteta (Benn, 2009).

Razumijevanje pojma otjelotvorenja vjere nudi uvid u suštinski značaj koji religija može imati na životno iskustvo. Posebno je korisna jer omogućava onima izvan vjere da potpunije shvate živote muslimana. Za neke muslimanske narode, privatnost i internacionalizacija vjere je njihov izbor, a za druge usvajanje hidžaba i veće javno ispoljavanje vjerskih uvjerenja je u centru njihovog vjerskog identiteta.

Tamo gdje nastava fizičkog vaspitanja ili sportsko okruženje ospori pravo muslimankama da ispoljavaju svoju vjeru, neminovni rezultat je neučestvovanje, pregovaranje ili prinuda. Dominantne zapadne škola i sportski modeli osmišljeni su u smislu percepcije kulture tijela i socijalne interakcije obrazaca koji nisu zastupljeni na globalnom nivou. Oni koji slijede slobodu da javno manifestuju "ispoljavanje vjere", što je čest slučaj u zajednicama dijaspore u neislamskim zemljama zahtijevaju poziciju različitosti kao manjine u pretežno sekularnom društvu.

Studija ilustruje različitosti u sklonostima mladih ljudi muslimana za određeni stepen pridržavanja zahtjeva islamskog oblačenja u nastavi fizičkog

lamic dress requirements in PE. Where embodied faith was strongest and religious identity most prominent in consciousness, then strict adherence to religious requirements was necessary. Where accommodation could not be found there were young people who just:

> Did not take part in PE at all (Iffat, Chamberlain School).

For all of the girls, arm and leg coverage was essential to retaining their embodied faith while participating:

> I would not feel comfortable wearing shorts (Madhia, Birchincliffe School).

Being persuaded or forced to transgress from what she perceived as a religious obligation created tension for her sense of religious identity. Strength of belief integrating faith, body and dress was also seen in other pupils. There was less of an issue with the use of single-sex classes. However, all related to different interpretations of the requirement for body modesty as one pupil (Lafiza) could not take part where there were boys. Other pupils chose not to wear any outward manifestation of their faith preferring a private, internalised faith. Important messages of diversity and close connections between identity, body and physicality are raised in such data. The notion of embodied faith increases understanding and sensitivity to the interface of Islam and physical activity participation. Here different cultural values centred on the body can underpin tensions that need to be resolved in the search for more inclusive pedagogical practices.

Tensions between educational practices and religious belief are important because, for many Muslims faith is the dominant determinant of pervasive values, behaviours and social relations. Issues at the interface of religion, ethnicity, gender, and physical activity are not unique to Islam but have been omnipresent historically where body practices and religious beliefs have been incongruent (Coakley, 2007). The centrality of Islam reflects its status as a "core life value", and is an "important part of everyday life" (Espositio & Mogahed, 2007, pp. 5, 21). While teachers had attempted to accommodate the needs of their pupils by making concessions on uniform and, in some cases, in organisation of teaching groups, there seemed to have been little involvement of pupils in this process. A belief that uniform rules were now accepted by students, following explanations from the teachers, was not confirmed by some of the students themselves, who, irrespective of their own culture, saw the school policy as unfair or racist. Their non-Muslim peers could wear track suit bottoms in the winter but not in the summer. The consequence of this was that the sample felt more visible during the summer months.

vaspitanja. Tamo gdje je otjelotvorenje vjere bilo najjače i vjerski identitet najprisutniji u svijesti onda je i bilo potrebno strogo pridržavanje vjerskih zahtjeva. Gdje se ta pozicija nije mogla pronaći bilo je mladih ljudi koji jednostavno:

> Uopšte nisu učestvovali u nastavi fizičkog vaspitanja (Iffat, Chamberlain škola).

Za sve djevojke, pokrivanje ruku i nogu u toku nastave fizičkog vaspitanja je neophodno da bi zadržale svoju vjeru sadržanu u otjelotvorenju:

> Ne osjećam se udobno u šorcu (Madhia, Birchincliffe škola).

Uvjeravana ili primorana da prekrši nešto od onoga što ona doživljava kao vjersku obavezu stvara tenziju u njenom osjećaju vjerskog identiteta. Snaga vjerovanja upotpunjuje vjeru, tijelo i oblačenje što je takođe vidljivo i kod drugih učenica. Manje problema je bilo kada su korišteni istopolni razredi. Međutim, sve je vezano uz različita tumačenja zahtjeva za skromnošću tijela. Jedna učenica (Lafiza) nije mogla učestvovati u nastavi tamo gdje su bili i momci. Ostale učenice su odlučile da ne nose nikakvu spoljašnju manifestaciju svoje vjere dajući prednost privatnoj, internoj vjeri. One su odrastale okružene važnim porukama različitosti i bliskih veza između identiteta, tijela i fizičkog izgleda. Pojam ispoljavanja vjere povećava razumijevanje i osjetljivost na tačku ineterakcije između islama i učešća u fizičkim aktivnostima. Tu različite kulturne vrijednosti usredsređene na tijelo mogu poduprijeti tenzije koje treba riješiti kroz inkluzivniju pedagošku praksu.

Tenzije između obrazovne prakse i vjerskog uvjerenja su važne jer za mnoge muslimane vjera je dominantna odrednica širenja vrijednosti, ponašanja i društvenih odnosa. Po pitanjima interakcije religije, etničke pripadnosti, pola i fizičke aktivnost nema jedinstvenog stava u islamu, ali su istorijski prisutna tamo gdje se ne podudaraju praksa tijela i vjerska ubjeđenja (Coakley, 2007). Centralna uloga islama izražava se kroz "jezgro vrijednosti života" i predstavlja "važan dio svakodnevnog života" (Espositio i Mogahed, 2007, str. 5, 21). Dok su nastavnici pokušali da zadovolje potrebe svojih učenika čineći ustupke u oblačenju i, u nekim slučajevima, u organizovanju nastavnih grupa, čini se da je malo angažovanje učenika u tom procesu. Uvjerenje da su jedinstvena pravila sada prihvaćena od strane učenika, nakon pojašnjenja od strane nastavnika, nije potvrđeno od strane samih učenika koji, bez obzira na vlastitu kulturu, vide školsku politiku kao nepravičnu ili rasističku. Njihove vršnjakinje nemuslimanke mogu nositi donji dio trenerki zimi, ali ne i u ljetnim mjesecima. Uzorak ispitanica je toga više bio svjestan tokom ljetnih mjeseci.

It was evident from the girls' comments that Ramadan was an area, which caused tensions for the Muslim girls partly in relation to the inconsistent approach adopted by the teachers. This was further exacerbated at Birchincliffe School where "Athletics" had been scheduled. The Muslim Council of Great has produced a policy document of good practice, which states that during Ramadan there should not be any physically exerting activities such as Athletics. Some of the girls were also conscious of other pupils' reactions to their lack of participation during Ramadan and believed that the teachers could do more to raise their own levels of awareness and those of other pupils. The incidence of victimisation by teachers and other pupils was not universally shared but it did cause concern to some of the pupils as did the perceived lack of concern by the teachers.

CONCLUSIONS

The findings of this study support research that has emphasised the active role of the individual in shaping an ethnic identity (Khan, 2002; Rumbaut, 1994). Identity is seen as a dynamic product that is achieved rather than simply given. British Muslims are willing to adapt to those aspects of the indigenous culture that do not clash with their religio/cultural ethos. Culture is dynamic, not static. Immigrants retain the likeable features of their culture of origin and abandon the ones they dislike. They also adopt what they are impressed with from the culture of their adopted country and reject what they find unimpressive.

Some girls clearly felt strongly about ways in which their religious identity was compromised in the isolating, unsympathetic school situations they had experienced. This was in relation to Ramadan and was particularly evident amongst those students who had experience of being in a previous school where Muslim students were not in the minority. These students were able to make comparisons and discuss their experiences of how PE teachers understood their needs surrounding Ramadan in relative terms. At both Birchincliffe School and Chamberlain School, there was a small proportion of Muslim students, and hence, there were no provisions for religious requirements such as a prayer room. The Every Child Matters agenda applies to all, including meeting the needs of even a small minority of Muslim pupils. However, teachers need the competence, confidence and materials to use existing flexibility within the curriculum. The research verifies the need for whole school and departmental policies on Ramadan that

Iz komentara djevojaka evidentno je da je Ramazan područje koje dovodi do napetosti kod djevojaka muslimanki djelomično i zbog nekonzistentnog pristupa usvojenog od strane nastavnika. To je dodatno dovelo do pogoršanja u Birchincliffe školi gdje su "sportovi" bili u programu. Veliki muslimanski savjet je napravio dokument politike dobre prakse u kojem se navodi da tokom Ramazana ne bi trebalo biti nikakvih dodatnih fizički aktivnosti kao što je sport. Neke od djevojaka takođe su bile svjesne reakcije drugih učenika na njihove izostanke sa nastave fizičkog vaspitanja za vrijeme Ramazana i vjeruju da su nastavnici mogli učiniti više na podizanju vlastite svijesti i svijesti kod drugih učenika. Učestalost viktimizacije od strane nastavnika i drugih učenika nije opšta pojava ali je uzrok zabrinutost za neke od učenica kao i saznanje o nedostatku brige za to od strane nastavnika.

ZAKLJUČCI

Rezultati ove studije podržavaju istraživanje koje je naglasilo aktivnu ulogu pojedinca u oblikovanju etničkog identiteta (Khan, 2002; Rumbaut, 1994). Na identitet se gleda kao na dinamičan proizvod koji se prije postiže nego što se dobija. Britanski muslimani su spremni da se prilagode onim aspektima autohtone kulture koje se ne sukobljavaju sa njihovim religijsko/kulturnim etosom. Kultura je dinamična, a ne statična. Emigranti zadržavaju prihvatljiva obilježja svog kulturnog identiteta, a napuštaju ona koja im se ne dopadaju. Oni su takođe usvojili iz kulture svoje nove zemlje ono što ih je impresioniralo, a odbacili sve ono što im se učinilo neupečatljivim.

Neke djevojke jasno i snažno su osjetile načine na koje je njihov vjerski identitet bio ugrožen u izolovanim i bezosjećajnim školskim situacijama koji su doživjele. To se odnosilo na Ramazan i posebno je bilo vidljivo među onim učenicama koji su nosile iskustvo iz prethodne škole, gdje učenici muslimani nisu bili u manjini. Ti učenici su mogli da razgovaraju i uporede svoja iskustva o tome kako su nastavnici fizičkog vaspitanja shvatili njihove potrebe za vrijeme ramazanskog posta. I u Birchincliffe i u Chamberlain školi bio je mali broj muslimanskih učenika. Samim tim nije bilo odredbe za vjerske potrebe kao što je prostorija za molitvu. Every Child Matters podsjetnik odnosi se na sve, uključujući i zadovoljenje potreba čak i malog broja učenika muslimana. Međutim, nastavnicima su potrebne sposobnosti, povjerenje i pribor da bi koristili mogućnost da se prilagode unutar nastavnog plana i programa. Istraživanje potvrđuje potrebu politike za sve škole i pojedina odjeljenja o Ramazanu, koje odražavaju uzajamno priznavanje, razumijevanje i fleksibilnost. Rezultati takođe predstavljaju izazov za

reflect mutual recognition, understanding and flexibility. The findings also present a challenge to official inspection Reports for both schools, which observe that both schools were inclusive. The Muslim Council of Great Britain's Advice to Schools suggests that more co-operative working will serve to create an environment where children feel welcomed and valued. However, even with the best of intentions, the gap between rhetoric and reality means that some pupils have significant barriers to overcome before they can experience full inclusion. Creating a community based on equal status relationships is a key element in successful inclusion and in PE the opportunity to structure interactions certainly exists. What is clear is that casual interactions or the presence of a Muslim pupil in the PE setting is not enough to promote tolerance and acceptance. Indeed, the findings of the study suggest the move towards a more inclusive and democratic social situation in the PE class still remains a far-off goal.

zvanične inspekcijske izvještaje za obje škole koji su ih doživljeli kao inkluzivne. Muslim Council of Great Britain's Advice to Schools ukazuje da će kooperativniji proces poslužiti da se stvoriti okruženje u kojem će djeca da osjete inkluziju. Međutim, čak i uz najbolje namjere, jaz između retorike i stvarnosti znači da neki učenici imaju značajne barijere koje trebaju da savladaju prije nego što mogu da dožive potpunu inkluziju. Stvaranje zajednice na osnovama ravnopravnosti odnosa je ključni element za uspješno uključenju, a u predmetu fizičkog vaspitanje mogućnost da se ostvari interakcija svakako postoje. Ono što je jasno jeste da povremene interakcije ili prisustvo učenika muslimana na nastavi fizičkog vaspitanja nije dovoljna da se promovišu tolerancije i prihvatanje. Šta više, rezultati istraživanja ukazuju da je pomjeranja prema inkluzivnijoj i demokratskijoj društvenoj situaciji u nastavi fizičkog vaspitanja još uvijek dalek cilj.

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IDENTITÄT UND DIE TEILNAHME AN SCHULISCHEN SPORTUNTERRICHT IN ENGLAND VON MUSLIMISCHEN SCHÜLERINNEN

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Dieser Artikel stützt sich auf eine ethnographische Fallstudie Eine Gruppe von muslimischen Schülerinnen an zwei Schulen in England. Es untersucht die Fragen rund um ihre religiöse und ethnische Identität und ob dies nicht gegen die Teilnahme an schulischen Sportunterricht (PE). Der wesentliche Aspekt der Definition der Studie war das Aufzeigen von Wegen, in denen muslimische Schülerinnen, die speziell pakistanischer Herkunft, wahrgenommen und ihre unterschiedlichen Identitäten ausgehandelt als Muslim, insbesondere, wie Religion, Kultur und Geschlecht könnte ihre Teilnahme Sportunterricht zu beeinflussen. Innerhalb einer qualitativen Methodik und interpretivist Exploration Ansatz, Theorie der sozialen Identität die Studie untermauert. Der Begriff der sozialen Identität als dynamisches Zentrum der Studie war, weil sowohl auf kollektiver Ebene, scheint es zwischen den Generationen stattfindenden Veränderungen in der Wahrnehmung von Nationalität und Ethnizität und Religion in der pakistanischen Gemeinschaft zu sein, und auch auf der individuellen Ebene. Auch eine Konzentration auf Forschung Prozesse der Ziele, Datenanalyse und Interpretation erleichtert den muslimischen Mädchen »PE Erfahrungen, die empirischen qualitativen Daten, für die über einen Zeitraum von 20 Monaten gesammelt wurden, vor allem durch ausführliche Interviews Einsatz semi-strukturierten Interview explizieren Zeitpläne. Diese Aufstellungen wurden als notwendig erachtet, weil »Identität«, das primäre Konzept der Untersuchung

ist, existiert als abstraktes Konzept nicht nur auf die Sozialwissenschaftler, sondern auch der sozialen Akteurs. Systematische Beobachtung der Sportunterricht wurde auch um die Reflexion von emergenten Eigenschaften von PE-Unterricht erlauben zusammen mit der gelebten Erfahrung PE der Schüler durchgeführt. Die ausgewählte Stichprobe von 10 Jahre 11 (circa 15 Jahre alt) muslimische Mädchen in zwei Schulen wurde angenommen, dass vernünftigerweise in diesem Alter zu artikulieren und gedacht, um eine Kristallisation der Werte von der Schule eingeimpft und ein Ende durch den erzieherischen Prozess zu vertreten.

Die Ergebnisse der Studie zeigen, dass soziale Kategorien von Ethnizität und Religion eine wichtige Rolle spielen bei der Gestaltung der Identität der Mädchen, die unterstützende Familien haben mit Werten geformt zu einem großen Teil von einem islamischen Ethos. Die Mädchen empfinden PE als ein Subjekt, das für die Freiheiten nicht an anderer Stelle im Lehrplan und fand sie erkennen die Bedeutung der körperlichen Aktivität erlaubt. Jedoch bestätigt die Studie die Ergebnisse früherer Untersuchungen, wonach Fragen der Kit, Umkleidekabinen und Fasten während des Ramadans gestellte Probleme für muslimische Schüler gefunden, das sind Merkmale, die besonders verstärkt werden, wenn Lehrer nicht wissen um die Probleme. Einige Mädchen deutlich zu spüren stark über Wege, auf denen ihre religiöse Identität in den Trenn-, unsympathisch Schule Situationen erlebten sie kompromittiert wurde und vor allem in Bezug auf Ramadan und seine Auswirkungen auf den Grad der Beteiligung. Die Erkenntnisse auch die Unzulänglichkeiten der Lehrerausbildung und der ausschließenden Charakter der traditionellen Sportunterricht Einstellungen ausgesetzt. Es war offensichtlich, dass, obwohl Lehrer an integrativen Praxis begangen wurden, in Wirklichkeit sind die Erfahrungen der Schülerinnen und Schüler mehr angewiesen auf die Qualität der einzelnen Lehrer waren. Die Lehrer sind wirksam, wenn sie entsprechend geschult worden, um in multiethnischen Schulen zu unterrichten und sind daher empfindlicher auf die hiermit verbundenen Fragen. Multi-Kultur-und Rassismus-Bewusstsein Kurse scheinen für ein besseres Verständnis der Schülerinnen und Schüler unverzichtbar, und deren Bereitstellung für alle Lehrer, unabhängig von ihrer hierarchischen Stellung, vorteilhaft sein kann.

Schlüsselwörter: technisch-taktische Stuktur, die Faktoren, die Präzision, das Volleyballspielll

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PROMENE FIZIČKOG FITNESA MUŠKARACA STARIJIH OD 60 GODINA - PILOT STUDIJA

CHANGES IN PHYSICAL FITNESS OF MEN OLDER THAN 60 - A PILOT STUDY

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SUMMARY

The aim of this study was to determine the differences in physical fitness in men older than 60. Two hundred and seventy-two subjects were included in this study. All subjects were divided into five age categories, as follows: 90 subjects aged 60−64 (33%), 70 subjects aged 65−69 (26%), 50 subjects aged 70−74 (18%) 41 subjects aged 75−79 (15%) and 21subjects over the age of 80 (8%). All subjects performed a battery of tests called the senior fitness test. The test consists of six measures of physical fitness: 1) Back scratch, 2) Chair sit and reach, 3) 8 foot up and go, 4) 30 sec stand from the chair, 5) Arm curl, 6) 2-minutes step test. Results of body mass index showed that all subjects were overweight regardless of age category. There is no statistically significant difference ($p > .05$) in flexibility between subjects of different age groups after the age of 60. The greatest differences were found in lower and upper extremities strength. The subjects aged 60−64 significantly differ in the strength of the lower extremities ($p < .05$) compared to subjects aged 70−74 and 75−79 years of age. The greatest heterogeneity was found in the parameters of aerobic endurance, with values progressively decreasing from the age of 60 (78.60 ± 42.00) to 80 (73.68 ± 35.62). It could be concluded that there was increase of fat tissue, with reduced level of muscle activity. In addition, it could be stated that aging process decrease muscle strength and endurance in elderly people.

Key words: fitness, senior fitness test, elderly persons.

SAŽETAK

Cilj ovog istraživanja bio je da utvrdi razlike na polju funkcionalnog fitnesa kod muškaraca starijih od 60 godina. U istraživanje je bilo uključeno 272 ispitanika. Sve ispitanike smo podijelili u pet starosnih kategorija, i to: 60−64 godine bilo je 90 ispitanika (33%), 65−69 godina, 70 ispitanika (26%), 70−74 godine, 50 ispitanika (18%), 75−79 godina, 41 ispitanik (15%) i preko 80 godina starosti bio je 21 ispitanik (8%). Svi ispitanici su proveli bateriju testova pod nazivom senior fitnes test. Test se sastoji od šest mjera fizičkog fitnesa: 1) pokretljivost ramena, 2) pretklon na stolici, 3) osam stopa, 4) ustajanje sa stolice za 30 sekundi, 4) fleksija u zglobu lakta, 5) dvominutni step test. Body mass index pokazuje da su svi ispitanici prekomjerne tjelesne težine bez obzira kojoj starosnoj kategoriji pripadaju. Kod fleksibilnosti ne postoji statistički značajna razlika ($p > 0,05$) između ispitanika različite starosne dobi nakon 60. godine starosti. Ispitanici se najviše razlikuju po pitanju snage kako donjih, tako i gornjih ekstremiteta. Primijećeno je opadanje snage sa procesom starenja tako da se ispitanici starosne dobi 60-64 godina statistički značajno razlikuju u snazi donjih ekstremiteta ($p < 0,05$) od ispitanika starih 70-74 i 75-79 godina. Najveća heterogenost zabilježena je u parametrima aerobne izdržljivosti, gdje rezultati progresivno opadaju od 60 godine, gdje su zabilježene najveće vrijednosti (78,60 ± 42,00) do 80. godine starosti (73,68 ± 35,62). U ovoj studiji smo utvrdili da je došlo do povećanja količine masnog tkiva, smanjenja nivoa mišićne aktivnosti, kao i smanjenja mišićne snage i izdržljivosti procesom starenja.

Ključne riječi: fitness, senior fitnes test, stare osobe.

INTRODUCTION

Anthropometric, fitness and functional characteristics are closely associated with lifestyle, health and functional status of elderly persons (Perissinotto, Pisent, Sergi, & Grigoletto, 2002). Therefore, it is very difficult to give a standard interpretation of their values. The process of aging brings a lot of physiological and nutritional changes such as reduced body weight and body height (Milanovic, Pantelic, Trajkovic, & Sporiš, 2011). It is well known that overweight and obesity are closely associated with increased risk of cardiovascular disease, chronical disease, and reduced range of motion (Musta et al., 1999).

Longitudinal studies (Visser et al., 2003) has showed that body weight has decreased in elderly men and women after 60 years of age. In additional Sánche García et al. (2007) has stated that body weight significantly differs between men and women (70.3 vs. 62.7 kg), as well as height (163 vs. 152 cm). This findings are supported by other studies (Reddy & Papa Rao, 2010; Setiati et al., 2010). It is considered that after 75 years, BMI and anthropometric measures are significantly decresing in men and women.

Despite these anthropometric changes, the level of functional fitness is often used as a parameter for monitoring and evaluation of public health and almost always associated with health status. Rikli and Jones (2001) have defined functional fitness as the physical capacity to perform daily activities independently and without the appearance of fatigue. This monitoring is especially important for elderly people above 60 years for preventing many diseases, occurrence of immobilization and reduction of mortality rates. Neverthless, physical activity affects the occurrence of storage diseases and immobilization while at the same time raise the functional capabilities that can be maintained even after exercising (Toraman, Ayceman, & Yaman, 2005).

However, there are many barriers for the inclusion of elderly persons in the process of physical activity regardless of the nature of the exercise. Gender is one of the most important factors for elderly persons and their participation in sports and recreational activities (Trost, Owen, Bauman, Sallis, & Brown, 2002). It was found that women have lower level of participating in sports and recreational activities than men aged over 60> (Leslie, Fotheringham, Owen, & Bauman, 2001). Moschny, Platen, Klaaben-Mielke, Trampisch and Hinrichs (2011) concluded in their study that men are more engaged in sport activities than women (01:45 vs. 01:10 hours per week) while

UVOD

Antropometrijske, funkcionalne i fitness karakteristike su usko povezane sa stilom života, zdravstvenim i funkcionalnim statusom starih osoba (Perissinotto, Pisent, Sergi i Grigoletto, 2002). Zbog toga je veoma teško dati standardne interpretacije njihovih vrijednosti. Sam proces starenja sa sobom nosi veliki broj fizioloških i nutritivnih promjena, kao što su smanjenje tjelesne mase, ali i tjelesne visine (Milanović, Pantelić, Trajković i Sporiš, 2011). Dobro je poznato da su prekomjerna tjelesna masa i gojaznost usko povezane sa povećanjem rizika od nastanka kardiovaskularnih bolesti, zatim hroničnih oboljenja i smanjene funkcije pokretljivosti tijela (Musta i saradnici, 1999).

Longitudinalna studija (Visser i saradnici, 2003) pokazuje da tjelesna masa opada kod starih muškaraca i žena nakon 60. godine života. Takođe, težina tijela se značajno razlikuje između muškaraca i žena (70,3 prema 62,7 kg) kao i visina (163 prema 152 cm) prema studiji Sánche García i saradnici (2007), što su potvrdile i druge studije (Reddy i Papa Rao, 2010; Setiati i saradnici, 2010). Smatra se da je 75. godina života prekretnica po pitanju BMI i antropometrijskih mjera i kod muškaraca i kod žena.

Bez obzira na ove antropometrijske promjene, nivo funkcionalnog fitnesa se često koristi kao parametar praćenja i procjene zdravlja stanovništva i gotovo uvijek se povezuje sa zdravstvenim statusom. Njega možemo definisati kao fizički kapacitet za obavljanje svakodnevnih aktivnosti, nezavisno i bez pojave zamora, koji uključuje komponente kao što su: mišićna snaga i fleksibilnost donjih i gornjih ekstremiteta, aerobna izdržljivost i motorna agilnost/ dinamički balans (Rikli i Jones, 2001). Ovo praćenje je posebno važno kod starijih osoba iznad 60 godina zbog sprečavanja nastanka mnogih oboljenja, pojave inaktiviteta, ali i smanjenje stope mortaliteta. Nesumnjivo je jasno da fizičke aktivnosti utiču na odlaganje nastanka oboljenja i inaktiviteta, dok u isto vrijeme podižu funkcionalne sposobnosti koje mogu da se održe i nakon prestanka vježbanja (Toraman, Ayceman i Yaman, 2005).

Međutim, postoje brojne prepreke kada je riječ o uključivanju starih osoba u proces fizičkog vježbanja bez obzira na karakter same vježbe. Pol je jedan od uticajnih faktora učešća starih osoba u sportsko rekreativnim aktivnostima (Trost, Owen, Bauman, Sallis i Brown, 2002), tako da je potrebno ispitati potencijalne determinante fizičke aktivnosti odvojeno za svaki pol. Utvrđeno je da žene imaju niži nivo učešća u sportsko- rekreativnim aktivnostima u odnosu na muškarce starosne dobi 60> (Leslie, Fotheringham, Owen i Bauman, 2001). Studija Moschny, Platen, Klaaben Mielke, Trampisch i Hinrichs (2011) koja je paralelno pratila sportske aktivnosti i kućne poslove, zaključila je da su muškarci angažovaniji u sportskim

women spend more time per week in household work (04:00 vs. 03:00 h).

Separate analysis of different activities should provide deeper understanding of participation in various activities. But according to the author's knowledge, existing studies have focused on examining the potential forms of physical activity in older persons who are solely focused on one type of activity, examing only men or only women, or showing the results of all activities (Ashe, Miller, Eng, & Noreau, 2008; Chad et al., 2005; Haley & Andel, 2010; Kaplan, Newsom, McFarland, & Lu, 2001; Lawlor, Taylor, Bedford, & Ebrahim, 2002; Ruchlin & Lachs, 1999; Walsh, Pressman, Cauley, & Browner, 2001).

It was hypothesized that aging brings certain changes in anthropometric and fitness parameters of men older than 60. Therefore, the primary objective of this study was to determine differences in the field of functional fitness in men older than 60 which were divided into five age categories. A secondary objective was to determine which of the five age categories (60−64, 65−69, 70−74, 75−79 and over 80 years) carries the greatest changes.

METHODS

Subjects

Two hundred and seventy-two subjects were included in this study. All subjects were divided into five age categories, as follows: 90 subjects aged 60-64 (33%), 70 subjects aged 65-69 (26%), 50 subjects aged 70-74 (18%) 41 subjects aged 75-79 (15%) and 21subjects over the age of 80 (8%). General descriptive parameters are present in Table 1. The age of participants ranged from 60-91 years. All the participants provided written consent after being informed of the test protocol. The protocol of the study was approved by the Ethical Committee of the Faculty of sport and physical education, University of Nis and according to the revised Declaration of Helsinki. All subjects were first informed of the possible consequences of testing as well as the benefits of the research revealed their age population. Testing of all patients was in the period from October to December of 2011. Criteria for selecting participants were: age between 60 and 80 years, physically independent person - able to walk 20 feet without assistance or rest, lack of cognitive impairment and dementia, achieved 24 points for the educated and 18 points for the unqualified subjects in mini mental state evaluation (McDowell & Newell, 1996). Participants who were in the recovery phase of an acute illness, then the deaf and blind were

aktivnostima od žena (01:45 nasuprot 01:10 h), ali žene provode nedeljno više vremena u kućnim poslovima od muškaraca (04:00 nasuprot 03:00 h).

Odvojene analize različitih aktivnosti bi pomogle za razumijevanje učešća u različitim aktivnostima. Međutim, prema saznanju autora, postojeće studije su fokusirane na ispitivanje potencijalnih oblika fizičke aktivnosti kod starijih osoba koje su isključivo fokusirane na jednu vrstu aktivnosti, ocjenjujući samo muškarce, ili samo žene, ili pokazujući rezultate ukupnih aktivnosti (Ashe, Miller, Eng i Noreau, 2008; Chad i saradnici, 2005; Haley i Andel, 2010; Kaplan, Newsom, McFarland i Lu, 2001; Lawlor, Taylor, Bedford i Ebrahim, 2002; Ruchlin i Lachs, 1999; Walsh, Pressman, Cauley i Browner, 2001).

Pretpostavili smo da proces starenja sa sobom nosi i određene promjene kod antropometrijskih i fitnes parametara muškaraca starijih od 60 godina. Stoga je primarni cilj ovog istraživanja bio da utvrdi razlike na polju funkcionalnog fitnesa kod muškaraca starijih od 60 godina, podijeljenih u pet starosne kategorije. Sekundarni cilj bio je da utvrdimo koja od pet starosnih kategorija (60-64, 65-69, 70-74, 75-79 i preko 80 godina) sa sobom nosi najveće promjene.

METODE

Ispitanici

Dvije stotine sedamdeset i dva nasumično odabrana ispitanika bilo je uključeno u ovo istraživanje. Sve ispitanike podijelili smo u pet starosnih kategorija i to: 60-64 godine gdje je bilo 90 ispitanika (33%), 65-69 godina, 70 ispitanika (26%), 70-74 godine, 50 ispitanika (18%), od 75-79 godina, 41 ispitanik (15%) i preko 80 godina starosti bio je 21 ispitanik (8%). Generalni deskriptivni parametri ispitanika prikazani su u Tabeli 1. Starosna dob ispitanika kretala se u rasponu 60-91 godine. Učešće u studiji bilo je dobrovoljno i svako od ispitanika je mogao da se povuče u bilo kom trenutku testiranja. Istraživanje je odobreno od strane Etičke komisije Fakulteta sporta i fizičkog vaspitanja Univerziteta u Nišu, u skladu sa Helsinškom deklaracijom. Svi ispitanici su najprije informisani o eventualnim posljedicama testiranja, kao i o prednostima koje ovo istraživanje donosi njihovoj dobnoj populaciji. Testiranje svih ispitanika bilo je u periodu od oktobra do decembra mjeseca 2011. godine. Svi ispitanici bili su mentalno i fizički sposobni da učestvuju u studiji. Kriterijumi za izbor učesnika u ovoj studiji bili su: starost između 60 i 80 godina, fizički nezavisne osobe - u stanju da hodaju 20 metara bez pomoći ili pauze, bez kognitivnog oštećenja i demencije, tako da njihov zbir u mini mental skali iznosi 24 poena za obrazovanim i 18 poena za neobrazovane (McDowell i Newell, 1996). Ispitanici koji su bili u fazi oporavka od neke akutne

excluded. The research does not include subjects with cardiovascular system disorders because of the potential risks during the functional fitness tests.

All patients were mentally and physically able to participate in the study. People trained for this survey first conducted standard interviews with potential subjects individually or in small groups, at their homes or in the active centers for the elderly. Each participant gave his/her demographic characteristics and then approach to the testing of anthropometric measures and the Senior Fitness Test (SFT).

bolesti, zatim gluvi i slijepi, bili su isključeni. Takođe, istraživanjem nisu obuhvaćene osobe sa poremećajem kardiovaskularnog sistema zbog potencijalnih rizika tokom testiranja fizičkog fitnesa.

Obučene osobe za potrebe ovog istraživanja su najprije obavile standardni intervju sa potencijalnim ispitanicima individualno ili u malim grupama, kod njihovih kuća ili u aktivnim centrima za stare osobe. Svaki od ispitanika je najprije dao svoje demografske karakteristike, a zatim se pristupilo mjerenju antropometrijskih mjera i senior fitnes testa (SFT).

TABLE 1
General descriptive parameters (M ± SD).

TABELA 1
Generalni deskriptivni parametri (M ± SD).

Age category	*n* (%)	Body Height (cm)	Body Weight (kg)	BMI (kg/m^2)
60-64	90 (33%)	178.19 ± 6.65	80.88 ± 9.59	25.50 ± 3.02
65-69	70 (26%)	177.00 ± 9.35	84.54 ± 13.81	27.03 ± 4.15
70-74	50 (18%)	174.50 ± 7.71	79.78 ± 11.69	26.27 ± 4.00
75-79	41 (15%)	175.34 ± 7.79	78.27 ± 13.13	25.39 ± 3.67
80>	21 (8%)	176.43 ± 8.95	78.48 ± 10.44	25.25 ± 3.20
Total	272	176.64 ± 8.02	81.04 ± 11.93	26.00 ± 3.68

Legend: ***n*** - Number of respondents (Broj ispitanika); ***BMI*** - Body mass index (Indeks tjelesne mase); ***M*** - Sample mean (Aritmetička sredina); ***SD*** - Standard deviation (Standardna devijacija); Age category - Uzrasna kategorija; Body Height - Tjelesna visina; Body weight - Tjelesna težina (kg); Total - Ukupno.

Antrhropometric measures

Body height and body weight were measured according to the instructions of the International Biological Program–IBP (Weiner & Lourie, 1969). The body height was measured with a GPM anthropometer (Siber & Hegner, Zurich, Switzerland) to the nearest 0.1cm. Body weight was obtained by TANITA BC 540 (TANITA Corp., Arlington Heights, IL) to the nearest 0.1kg. Body mass index was calculated by formula: BMI = body weight (kg) / (body height (m^2).

Senior fitness test

Senior fitness test is a battery of tests for the assessment of the functional fitness of older persons. This test assesses the physiological capacity for carrying out normal daily activities independently and safely without the appearance of fatigue. Before testing, the subjects have performed 10 minutes warm up with the instructions given by highly skilled persons, and then a complete SFT with the tasks order referred in this test (Rikli & Jones, 2001). This test has validity by Rikli and Jones (1999). The test consists of six

Antropometrijske mjere

Antropometrijske mjere, mjerene su u skladu sa preporukama Internacionalnog biološkog programa – IBP (Weiner i Lourie, 1969). Visina tijela mjerena je mjernom trakom, sa tačnošću 0,1 cm. Težina tijela procijenjena je pomoću decimalne vage, sa tačnošću 0,1 kg. Body mass index (BMI) izračunat je indirektno na osnovu zabilježenih vrijednosti mase i visine tijela, pomoću formule BMI = masa tijela (kg) / visina tijela (m^2).

Senior fintes test

Senior fintes test je baterija testova za procjenu funkcionalnog fitnesa starijih osoba. Ovaj test procjenjuje fiziološki kapacitet za izvođenje normalnih svakodnevnih aktivnosti, nezavisno i bezbjedno, bez pojave zamora. Prije izvođenje testa, ispitanici najprije odrade desetominutno zagrijevanje, vođeno od strane obučenih osoba, a zatim izvode kompletan SFT po redoslijedu zadataka koji se navode u ovom testu (Rikli i Jones, 2001). Ovaj test je potvrđen od strane Rikli i Jones (1999). Test se sastoji od šest mjera fizičkog fitnesa:

measures of functional fitness: 1) Back scratch, 2) Chair sit and reach, 3) 8-foot up and go 4) Chair stand up for 30 sec, 5) Arm curl, 6) 2-minutes step test. Back scratch is the test for the assessment of upper body (shoulder) flexibility. Each subject is performing two test trials and then two attempts which are measured and included for further analysis. The result is the shortest distance between extended middle fingers. Chair sit and reach is a test for the assessment of lower extremities flexibility. As with the previous test, each subject is performing two test trials and two attempts to be measured and included in further analysis. The result is the longest distance between extended fingers and tip of toes. 8-foot up and go assess agility/dynamic balance. Each subject is performing one test trial and two attempts to be measured and included in further analysis. The result is the shortest time in seconds required from subject to get up from a seated position, walk 8 feet, turn, and return to seated position. Chair stand up for 30 sec is the test for the assessment of lower body strength. Each subject has two test trials after which the protocol of measurement occurs where subject has to perform maximal number of full stands in 30 seconds. Arm curl is the test for the assessment of upper body strength. Each subject has two test trials and then the test is finished after 30 seconds. The result is the number of bicep curls in full range of motion that can be completed in 30 seconds. 2-minutes step test is muscle endurance test. The subject, turned against the wall, has to perform maximal number of full steps with requested hight in 2 minutes. The test is performed only once and subject doesn't run but walk as fast as he can.

Statystical analysis

The statistical Package for Social Studies SPSS (v17.0., SPSS Inc., Chicago, IL) was used for statistical analysis. Descriptive statistics were reported as mean ± *SD* for all measures. To determine the differences between age groups we used univariate analysis of variance (ANOVA). We used Bonferroni correction to determine which of groups are statisticaly different. The statistical significance was set at $p < .05$.

RESULTS

The largest number of subjects were in the age category of 60−64 (33%). With the increase of age, the number of subjects reduces so that in the category over the age of 80 was only 8% of subjects. Body height was quite similar between groups and ranged from 178.19 ± 6.65 cm in subjects 60−64

1) pokretljivost ramena, 2) pretklon na stolici, 3) osam stopa, 4) ustajanje sa stolice za 30 sekundi, 4) fleksija u zglobu lakta, 5) dvominutni step test. Pokretljivost ramena procjenjuje fleksibilnost gornjih ekstremiteta. Svaki ispitanik izvodi po dva probna pokušaja i dva pokušaja koja se mjere i ulaze u dalju analizu. Rezultat predstavlja najkraća udaljenost između opruženog srednjeg prsta obje ruke. Pretklon na stolici je test koji je procjenjuje fleksibilnost donjih ekstremiteta. Kao i kod prethodnog testa, svaki ispitanik izvodi po dva probna pokušaja i dva pokušaja koja se mjere i ulaze u dalju analizu. Rezultat predstavlja najveća distanca između opruženih prstiju ruke i vrhova nožnih prstiju. Test 8 stopa procjenjuje agilnost i dinamički balans. Svaki od ispitanika izvodi jedan probni pokušaj i dva koja se mjere i kasnije analiziraju. Rezultat je najkraće vrijeme postignuto od trenutka ustajanja sa stolice, pređenih osam stopa, okreta i povratka u sjedeću poziciju. Ustajanje sa stolice je test kojim se procjenjuje snaga donjih ekstremiteta. Svaki ispitanik ima dva probna pokušaja, a zatim se pristupa protokolu mjerenja koji podrazumijeva maksimalni broj ustajanja koje može da izvede ispitanik za 30 sekundi. Test fleksija u zglobu lakta procjenjuje snagu gornjih ekstremiteta. Svaki od ispitanika najprije uradi dva probna pokušaja, a zatim kompletira test u trajanju od 30 sekundi. Kao rezultat računa se ukupan broj ponavljanja, sa rasponom pokreta izvedenih u 30 sekundi. Dvominutni step test je test kojim se procjenjuje mišićna izdržljivost. Ispitanik okrenut licem prema zidu, treba da izvede maksimalni broj koraka do zadate visine u dva minuta. Test se izvodi samo jednom, a ispitanik za vrijeme ovog testa ne trči, već hoda što je brže moguće.

Statistička analiza

Prikupljeni podaci obrađeni su pomoću statističkog programa SPSS 17.0 (SPSS Inc., Chicago, IL). Deskriptivni statistički parametri izračunati su za svaku varijablu. Za utvrđivanje razlike između starosne kategorije kojoj ispitanici pripadaju korišćena je univarijantna analiza varijanse (ANOVA). Za utvrđivanje statistički značajnih razlika između grupa starosne dobi primijenjena je Bonferonijeva korekcija. Statistička značajnost bila je $p < 0,05$.

REZULTATI

Najveći broj ispitanika bio je u starosnoj kategoriji 60-64 godine (33%), dok je sa porastom broja godina broja ispitanika opadao, tako da je u kategoriji preko 80 godina starosti bilo svega 8% ispitanika. Tjelesna visina bila je dosta ujednačena između grupa i kretala se u rasponu od 178,19 ± 6,65 cm kod osoba 60-64

years of age to 174.50 ± 7.71 cm in subjects 10 years older (70−74 years of age). Also statistically significant difference was found for body weight ($p < .05$). Results of body mass index showed that all subjects were overweight regardless to the age category (Table 1). The highest values of BMI were recorded in men aged 65−69 (BMI = 27.03 ± 4.15 kg/m^2) and the lowest in the oldest subjects, over the age of 80 (25.25 ± 3.20 kg/m^2).

Table 2 shows that there is no statistically significant difference in flexibility between subjects of different age groups after the age of 60. Also, results for agility and dynamic balance (8 foot up and go test) have showed that there is no statistical difference between groups. The greatest differences were found in lower and upper extremities strength. The subjects aged 60−64 significantly differ in the strength of the lower extremities ($p < .05$) compared to subjects aged 70−74 and 75−79. Upper limbs strength significantly differes between subjects aged 60−64 and 70−74 (18.16 ± 4.87 vs 16.37 ± 5.90 repetitions). The greatest heterogeneity was found in the parameters of aerobic endurance, with values progressively dec-

godine starosti, do 174,50 ± 7,71 cm kod osoba 10 godina starijih (70-74 godine starosti). Takođe statistički značajna razlika nije pronađena ni kada je tjelesna masa u pitanju ($p > 0,05$). Posmatrani kroz sferu body mass index-a, svi ispitanici su prekomerne tjelesne težine bez obzira kojoj starosnoj kategoriji pripadaju (Tabela 1). Najveće vrijednosti BMI zabilježene su kod muškaraca starosti 65-69 godina (BMI = 27,03 ± 4,15 kg/m^2), dok je najniža kod najstarijih ispitanika, preko 80 godina starosti, i iznosi 25,25 ± 3,20 kg/m^2.

Iz Tabele 2 vidimo da kada je riječ o fleksibilnosti, ne postoji statistički značajna razlika između ispitanika različite starosne dobi nakon 60 godina starosti. Takođe, u parametrima za procjenu agilnosti i dinamičkog balansa (osam stopa test), nije utvrđena statistički značajna razlika između grupa. Ispitanici se najviše razlikuju po pitanju snage kako donjih, tako i gornjih ekstremiteta. Primijećeno je opadanje snage sa procesom starenja tako da se ispitanici starosne dobio 60-64 godine statistički značajno razlikuju u snazi donjih ekstremiteta ($p < 0,05$) od ispitanika starih 70-74 i 75-79 godina starosti. Kada je riječ o gornjim ekstremitetima, razlikuju se grupe ljudi od 60-64 i 70-74 (18,16 ± 4,87 nasuprot 16,37 ± 5,90 ponavljanja)

TABLE 2
Senior fitness test according to age category (M ± SD).

TABELA 2
Parametri senior fitness testa po starosnim kategorijama (M ± SD).

	Male				
	60−64	65−69	70−74	75−79	80>
Back scratch (cm)	-6.45±8.90	-9.03±9.23	-9.85±12.78	-7.98±11.61	-10.74±11.50
Seat and reach (cm)	.11±6.87	-.60±10.53	4.05±9.43	1.38±8.24	.73±9.00
8 foot up and go (sec)	7.52±6.54	8.10±2.91	9.84±8.88	7.84±3.34	7.97±3.34
30 sec stands from chair (rep)	15.34±4.32$^{\Omega\,\#}$	13.90±5.87	14.45±5.05$^{\Omega}$	12.43±5.24$^{\#}$	12.74±5.10
Arm curle (rep)	18.16±4.87$^{\Omega}$	16.54±6.19	16.37±5.90$^{\Omega}$	16.76±7.08	16.79±5.11
2 - minute step test (rep)	78.60±42.90$^{\Omega\,\#}$	75.64±57.80‡	67.44±33.92$^{\Omega}$	55.46±40.97$^{\#\ddagger}$	73.68±35.62

Legend: ***** - Statistically significant difference between age 65−69 and 70−74 (Statistički značajna razlika između starosne dobi 65−69 i 70−74); **¶** - Statistically significant difference between age 65−69 and 80> (Statistički značajna razlika između starosne dobi 65−69 i 80>); **†** - Statistically significant difference between age 60−64 and 65−69 (Statistički značajna razlika između starosne dobi 60−64 i 65−69); **‡** - Statistically significant difference between age 65−69 and 75−79 (Statistički značajna razlika između starosne dobi 65−69 i 75−79); **Ω** - Statistically significant difference between age 60−64 and 70−74 (Statistički značajna razlika izmedju starosne dobi 60−64 i 70−74); **#** - Statistically significant difference between age 60−64 and 75−79 (Statistički značajna razlika izmedju starosne dobi 60−64 i 75−79); Male - Muškarci; Back scratch - Pokretljivost ramena; Seat and reach - Pretklon na stolici; 8 foot up and go - Osam stopa; 30 sec stands from chair - Ustajanje sa stolice za 30 sekundi; Arm curle - Fleksija u zglobu lakta; 2 - minute step test - Dvominutni step test; **rep** - Repetition (Ponavljanja).

reasing from the age of 60 (78.60 ± 42.00) to 80 (73.68 ± 35.62).

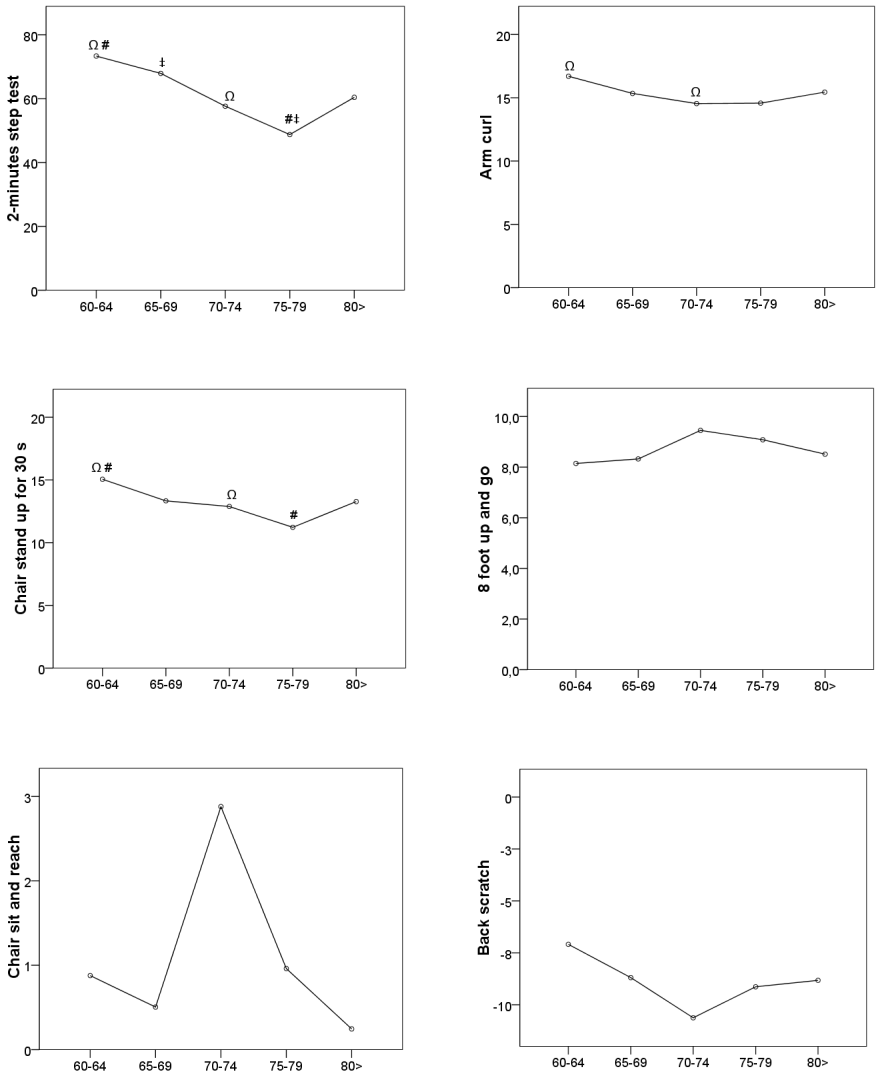
godine starosti. Najveća heterogenost zabeležena je u parametrima aerobne izdržljivosti gdje rezultati progresivno opadaju od 60 godine, i tu su zabilježene najveće vrijednosti (78,60 ± 42) do 80 godine starosti.

FIGURE 1

Changes in physical fitness in relation to age.

SLIKA 1

Trend promena fizičkog fitnesa u odnosu na godine starosti.



Legend: Back scratch - Pokretljivost ramena; Seat and reach - Pretklon na stolici ; 8 foot up and go - Osam stopa; 30 sec stands from chair - Ustajanje sa stolice za 30 sekundi; Arm curle - Fleksija u zglobu lakta; 2 - minute step test - Dvominutni step test.

DISCUSSION

Promoting a healthy lifestyle of the elderly has become more important due to the dramatic increase in population over the last two decades. The level of physical activity is often used as a parameter for monitoring and evaluation of public health. This monitoring is especially important for the elderly to

DISKUSIJA

Promocija zdravog stila života starih osoba postaje značajnija zbog dramatičnog uvećanja broja ovih osoba tokom posljednje dvije decenije. Nivo fizičke aktivnosti se često koristi kao parametar praćenja i procjene javnog zdravlja stanovništva. Ovo praćenje je posebno važno kod starih osoba zbog prevencije mnogih

prevent many diseases, occurrence of immobilization and reduction of mortality rate (Milanovic et al., 2011).

The average height and weight of the participants was 176.64 ± 8.02 cm, 81.04 ± 11.93 kg respectively, which was greater than the results shown in the study Velazguez Alva et al. (1996) who recorded the average value for men of the same age 163.8 ± 5.53 cm, 70.07 ± 9.92 kg, as indicated by other studies (Cicioglu, 2010; Sánchez García et al., 2007; Setiati et al., 2010). The results of our study are similar with study Guo, Zeller, Chumlea, and Siervogel (1990), who found that the total weight increases from the age of 60 to 70. However, in the study Visser et al. (2003) body weight increses after the age of 60 which is contrary to our results. The values of BMI show that subjects in our study are overweight (BMI > 25), which could lead to the emergence of various chronic diseases and reducing capacity (Pai, 2011; Perissinotto et al., 2002). Obesity is one of the most occurent public health problems which can be effectively prevented (Milanovic et al., 2011). Perissinoto et al. (2002) found lower BMI values between the ages of 65−75 than in the period between 75−80, which is contrary with our results. The results of our study have confirmed the trend of incresed obesity among elderly people in the last two decades (Misra & Khurana, 2008). Aging is associated with a higher percentage of body fat and body fat redistribution. Distribution of lower-body subcutaneous adipose tissue in the abdominal and visceral part is the most common with the elderly people. The reduction in BMI occurs due to the loss of muscle mass and increase of fat tissue in waist and hips.

Given that this study has only analyzed BMI parameter, a clearer picture of the redistribution of body fat is necessary for a future study. In our study, decrease in muscle strength of upper and lower extremities with progressive increase in the number of years is noticeable. Decrease in muscle strength during the aging process is the result of significant loss of muscle mass, which may cause the decrease in physical activity (Радовановић & Игњатовић, 2009) but also increase the risk of falls and injuries in older people. Sedentary lifestyle has significant impact on muscle mass and increases subcutaneous adipose tissue. The results of this study clearly show that men are less physically active with aging proces which could be reflected on their muscular strength and endurance. Our study has shows statistically significant decrease of aerobic endurance in subjects aged 60−64 and those older than 75. Thus, the reduction of muscle function should be attributed to a combination of factors such as aging and physical inactivity (Shephard, 1997; Spirdusso, 1995). This could be confirmed by Jozsi, Campbell, Joseph,

oboljenja, nastanka inaktiviteta, ali i smanjenje stope mortaliteta (Milanović i saradnici, 2011).

Prosečna tjelesna visina i težina ispitanika bila je 176,64 ± 8,02 cm, 81,04 ± 11,93 kg, što je daleko više od rezultata prikazanih u studiji Velazguez-Alva i saradnici (1996) (163,8 ± 5,53 cm, 70,07 ± 9,92 kg). Rezultati našeg istraživanja su slični sa rezultatima studije (Cicioglu, 2010; Sánchez García i saradnici, 2007; Setiati i saradnici, 2010). Rezultati slične studije (Guo, Zeller, Chumlea i Siervogel; 1990) koja pokazuju da se ukupna tjelesna masa povećava od 60 do 70 godina starosti. Međutim, u studiji Viser i saradnici (2003) tjelesna težina se povećava nakon 60 godine, što je suprotno našim rezultatima. Vrijednosti BMI pokazuju da su ispitanici u ovoj studiji prekomerne tjelesne težine (BMI > 25), koja može da dovede do pojave različitih hroničnih oboljenja i smanjenja sposobnosti (Pai, 2011; Perissinotto i saradnici, 2002). Gojaznost je jedan od najučestalijih javnozdravstvenih problema na koji se može efektivno preventivno djelovati (Milanović i saradnici, 2011). Perissinoto i saradnici (2002) su pronašli niže vrijednosti BMI između starosne dobi 65-75 nego u periodu između 75-80 godina života, što je suprotno našim rezultatima. Rezultati ove studije su samo potvrdili trend povećanje broja gojaznih starih osoba u posljednje dvije decenije, (Misra i Khurana, 2008). Starenje je povezano sa povećanjem udela masnog tkiva i preraspodele tjelesne masti. Preraspodela masti pretežno iz donjeg dela tijela u abdominalni i visceralni dio je najčešće zastupljena kod starih osoba. Smanjenje BMI nastaje zbog gubitka mišićne mase i povećanja masnog tkiva u predjelu struka i kukova.

S obzirom da smo u ovoj studiji analizirali samo parametar BMI, izostaje jasnija slika o preraspodjeli tjelesnih masti kod ispitanika, a koja je neophodna za buduća istraživanja. U našoj studiji primjetno je smanjenje mišićne snage kako donjih, tako i gornjih ekstremiteta progresivno sa povećanjem broja godina. Smanjenje mišićne snage tokom procesa starenja rezultat je značajnog gubitka mišićne mase, što može da prouzrokuje i smanjenje fizičke aktivnosti (Радовановић & Игњатовић, 2009), ali i povećanje rizika od padova i nastanka povreda kod starijih osoba. Sedentarni način života ima značajan uticaj na mišićnu masu i povećanje potkožnog masnog tkiva. Rezultati ove studije očigledno pokazuju da su muškarci manje fizički aktivni sa procesom starenja, što se može odraziti na njihovu mišićnu snagu i izdržljivost. Naša studija pokazuje statistički značajno smanjenje aerobne izdržljivosti kod ispitanika 60-64 godine i onih starijih od 75 godina. Dakle, smanjenje funkcije mišića treba pripisati kombinaciji faktora kao što su starenje i smanjena fizička aktivnost (Shephard, 1997; Spirdusso,

Davey, and Evans (1999), and Toraman et al. (2005) who found that appropriate level of training can maintain muscle strength and endurance. Another reason for decrease in muscle strength and endurance is to reduce the number of muscle fibers during the aging process. The results show that approximately 10% of muscle fibers are lost during each decade after the age of 50 (Lexell, Taylor, & Sjöström, 1988). On the other side, the aging process leads to reduction in activation of motor units (Радовановић & Игњатовић, 2009).

It could be concluded that there was increase of fat tissue, with reduced level of muscle activity. In addition, it could be stated that aging process decrease muscle strength and endurance in elderly people. These parameters could lead to a greater risk of cardiovascular and respiratory diseases. Thus their work ability and physical fitness are many times reduced. Negative factors should be eliminated in order to prevent obesity and thus the above mentioned deseases. Reducing body fat could lead to better physical fitness and working capacity. Regular physical activity and functional fitness could slow down the aging process.

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1995). Potvrdu ovome daje studija Jozsi, Campbell, Joseph, Davey i Evans (1999) i Toraman i saradnici (2005), koja je ustanovila da se adekvatnim treningom može održati mišićna snaga i izdržljivost. Drugi razlog smanjenja mišićne snage i izdržljivosti jeste smanjenje broja mišićnih vlakana tokom procesa starenja. Rezultati istraživanja pokazuju da se gubi približno 10% mišićnih vlakana u toku svake decenije nakon 50. godine života (Lexell, Taylor i Sjöström, 1988). Sa druge strane, proces starenja dovodi do redukcije u aktivaciji motornih jedinica (Радовановић & Игњатовић, 2009).

Možemo zaključiti da je došlo do povećanja količine masnog tkiva, uz redukciju nivoa mišićne aktivnosti. Pored toga, može se konstatovati da se procesom starenja smanjuje mišićna snaga i izdržljivost starih osoba. Ovi parametri mogu dovesti do povećanja rizika nastanka kardiovaskularnih i respiratornih bolesti. Prema tome njihove radne sposobnosti i fizički fitnes su mnogostruko smanjeni. Negativne faktore bi trebalo ukloniti u cilju prevencije gojaznosti i gore navedenih bolesti. Smanjenje tjelesnih masti može da dovede do boljeg nivoa fizičkog fitnesa i radnog kapaciteta. Regularna fizička aktivnost i funkcionalni fitnes mogu da uspore proces starenja.

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ИЗМЕНЕНИЯ В ФИЗИЧЕСКОЙ ПОДГОТОВЛЕННОСТИ МУЖЧИН СТАРШЕ 60 ЛЕТ - ПИЛОТНОЕ ИССЛЕДОВАНИЕ

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Вне зависимости от антропометрических изменений, уровень функциональной пригодности часто используется в качестве параметра для мониторинга и оценки состояния здоровья населения и почти всегда связано с состоянием здоровья. Она определяется как физические способности выполнять повседневную деятельность самостоятельно и без появления усталости, которая включает в себя такие компоненты, как мышечная сила и гибкость нижних и верхних конечностей, аэробика izdrđljivost и двигатель ловкость / динамическое равновесие. Это наблюдение особенно важно для пожилых людей старше 60 лет профилактики заболеваний, появление иммобилизация и снижение смертности. Безусловно, ясно, что физическая активность влияет на возникновение болезни и хранение иммобилизации и в то же время повышение функциональных возможностей, которые могут быть сохранены даже после прекращения физической нагрузки.

Предположим, что процесс старения влечет за собой определенные изменения в антропометрические параметры и фитнес-мужчин старше 60 лет. Таким образом, основной целью данного исследования было определение различий в области функциональной пригодности у мужчин старше 60 лет были разделены на пять возрастных категорий. Вторая цель заключалась в определении, какая из пяти возрастных категорий (60-64, 65-69, 70-74, 75-79 и старше 80 лет) приносит большие изменения.

Двести семьдесят два случайно выбранных пациентов были включены в данное исследование. Все испытуемые были разделены на пять возрастных категорий, а именно: 60-64 лет, где было 90 субъектов (33%), 65-69 лет 70 (26%), 70-74 лет 50 (18%), из 75 - 79 лет 41 (15%), и в течение 80 лет было 21 человек (8%).

Все предметы выполнены тестов называется старший тест пригодности. Тест состоит из шести мер физической культуры: 1) подвижность плеча, 2) достигает на стуле, 3) восемь футов, 4) вставая со стула в течение 30 секунд, 4) сгибание в локтевом суставе, 5) две минуты шагом испытаний. Индекс

массы тела показал, что все респонденты имеют избыточный вес независимо от того, какой возрастной группе они принадлежат. Для обеспечения гибкости, нет статистически значимых различий (p> 0,05) между респондентами разного возраста после 60 лет. Респонденты самые разные точки зрения власти на нижних и верхних конечностей. Это наблюдается упадок сил с процессом старения, так что респонденты в возрасте 60-64 лет, статистически значимых различий в силе нижних конечностей лиц в возрасте 70-74 и 75-79 лет. Наибольшая неоднородность наблюдается в параметрах аэробной выносливости с оценками постепенно снизилась с 60 лет, где они записали самые высокие значения (78,60 ± 42) до 80 лет.

В этом исследовании мы обнаружили, что произошло увеличение жировой ткани, уменьшая уровень мышечной активности и снижение мышечной силы и выносливости процесс старения. Сочетание этих параметров, некоторые из риска сердечно-сосудистых и респираторных заболеваний наших пациентов подвергаются во много раз более высокий риск развития этих заболеваний. Таким образом, их способность работы и физической подготовки во много раз ниже. Негативные факторы, которые влияют на работоспособность, например, чрезмерное количество жира должно ukoniti, пока ситуация не возникает, что не может быть исправлена. За счет уменьшения жира предотвращает снижение физической культуры и работоспособность. Физическая активность и фитнес-тренировки и поддержания функциональной пригодности, который уменьшает процесс старения.

Ключевые слова: фитнес, фитнес-тест старшего, пожилого

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RAZLIKE U FIZIOLOŠKOM OPTEREĆENJU SUDIJA S OBZIROM NA PERIOD KOŠARKAŠKE UTAKMICE

DIFFERENCES IN PHYSIOLOGICAL LOAD OF THE REFEREES WITH CONCIDERATION TO THE PERIOD OF THE BASKETBALL GAME

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SUMMARY

The main object of this research was to determine the existance of statistically significant differences in physiological load of the referees concidering the period of the basketball game. The sample of subjects consisted of 31 referees, avarage age of 33.35 ± 5.17, from the A referee list of the 1st Croatian Basketball League in the contest season 2008/2009. The sample of variables consisted of the following: *FSM - avarage heart rate*; *Fsmax – maximum heart rate*; *E – energy consumption* (kcal/min). Measuring was done during official games of the 1st Croatian Basketball League in the contest season of 2008/2009. During the game, heart rate was measured with a cardiotachometer (an electronic device for heart rate measurement), produced by *POLAR*, *model RS400* (Finland). Data processing was done using a programme package STATISTICA for Windows, ver 8. Based on the obtained results of univariate variance analysis it was concluded that there are no statistically significant differences in the physiological load between the first and second half – time, as well as between particular quarters of basketball games.

Key words: physical – motor preparation, heart rate, energy consumption.

SAŽETAK

Glavni cilj u ovom istraživanju bio je utvrditi postoje li statistički značajne razlike u fiziološkom opterećenju sudija s obzirom na period košarkaške utakmice. Uzorak ispitanika sastojao se od 31 sudije, prosječne dobi 33,35 ± 5,17 godina koji su se nalazili na A listi sudija I. Hrvatske košarkaške lige u takmičarskoj sezoni 2008/2009. Uzorak varijabli činile su sljedeće varijable: *FSM - prosječna frekvencija srca*; *FSmax - maksimalna frekvencija srca*; *E - energetska potrošnja* (kcal/min). Mjerenje je izvršeno za vrijeme službenih, takmičarskih utakmica I. Hrvatske košarkaške lige u takmičarskoj sezoni 2008/2009. Frekvencija srca tokom utakmice mjerena je kardiotahometrom (elektronskim mjeračem frekvencije srca) proizvođača POLAR, *model* RS400 (Finska). Obrada podataka izvršena je primjenom programskog paketa STATISTICA for Windows, ver 8. Na osnovu rezultata univarijatne analize varijanse, zaključeno je da ne postoje statistički značajne razlike u fiziološkom opterećenju između prvog i drugog poluvremena, kao i pojedinih četvrtina košarkaške utakmice.

Ključne riječi: kondiciono - motorička pripremljenost, frekvencija srca, energetska potrošnja..

INTRODUCTION

In now days basketball is charactarized by high level of activity in all 40 minutes of its duration, which demands a great physical – motor preparation of the players (Matkovic, Matkovic, & Knjaz, 2005). The past researches of physiological load of the players during a game have pointed out to its high level of intensity (Beam & Merril, 1994; Hoffman, 2003). The avarage heart rate of the players during a game is at 87% of the maximum heart rate (McDougal, Wegner, & Green, 1991), or in other words, 75% of the total game time the players heart rate amounts above 85%, and 15% of the time amounts above 95% of the maximum heart rate (McInnes, Carlson, Jones, & McKenna, 1995).

Both the players and the basketball referees make a component part of every basketball game. The ultimate outcome of most baketball games is decided in the last minutes when the level of physical – motor preparation of the players, their psychological stability and changes in team tactics, greatly influence the final number of technical – tactical errors and errors that result from disregarding the regulations of the game of basketball (Mildenhall & Holmin, 2004). To make the referees decision as better and more correct as possible, during the game the referee always has to be at the right place and have a quality point of view of the situation. The stated surely demands a great physical preparation of the referees, as well as good visual perception, mental ability, focus of attention, readiness and ability to make fast decisions. Regardless of great importance of the basketball referees, there are very few scientific researches which have delt with them as their main topic. The past researches of the physiological load of the basketball referees have shown a great level of stress to their organism.

The referees are exposed to high level of load while officiating an entire game, especially in the final moments when their activity in the sence of making a larger number of rulings, increases. In other words it can be assumed that physiological load of the referees changes as the game is coming to an end. The main object of this paper was to determine the existence of statistically significant differences in physiological load of the referees concidering a period of the basketball game.

METHODS

Sample of subjects

The sample of subjects consisted of 31 referees avarage age of 33.35 ± 5.17, from A referee list of the 1st Croatian Basketball League, season 2008/2009.

UVOD

Savremenu košarku karakteriše visok intenzitet aktivnosti u svih 40 minuta trajanja, koji od igrača zahtijeva odličnu kondiciono-motoričku pripremljenost (Matković, Matković i Knjaz, 2005). Dosadašnja istraživanja fiziološkog opterećenja igrača za vrijeme igre ukazala su na njen visok intenzitet (Beam i Merrill, 1994; Hoffman, 2003). Prosječna frekvencija srca igrača za vrijeme igre nalazi se na 87% od maksimalne frekvencije srca (McDougal, Wegner i Green, 1991), odnosno igračima se 75% vremena od čiste igre frekvencija srca nalazi iznad 85%, a 15% vremena iznad 95% od maksimalne frekvencije srca (McInnes, Carlson, Jones i McKenna, 1995).

Kako igrači, tako i košarkaške sudije čine sastavni dio svake košarkaške utakmice. Krajnji ishod većine košarkaških utakmica odlučuje se u završnim trenucima, kada nivo kondiciono-motoričke pripremljenosti igrača, njihova psihička stabilnost, te promjene u taktici igre same ekipe uveliko utiču na konačan broj učinjenih tehničko - taktičkih grešaka i grešaka koje proizlaze iz nepoštivanja pravila košarkaške igre (Mildenhall i Holmin, 2004). Kako bi odluka sudije bila što je moguće bolja i ispravnija, sudija tokom igre mora uvijek biti na pravom mjestu i imati kvalitetan pregled situacije. Ovo sigurno zahtijeva odličnu kondicionu pripremljenost sudije, ali uz to i dobru vizuelnu percepciju, mentalnu sposobnost, fokusiranost pažnje, spremnost i sposobnost za donošenje brzih odluka. Bez obzira na vrlo značajnu ulogu košarkaških sudija, vrlo je malo naučnih istraživanja koja su se bavila njima kao svojom glavnom temom. Sprovedena istraživanja fiziološkog opterećenja košarkaških sudija pokazala su visok stepen opterećenja na njihov organizam.

Sudije su izloženi visokom opterećenju tokom suđenja cijele utakmice, a posebno u njenim krajnjim trenucima, kada se povećava njihova aktivnost u smislu većeg broja donesenih odluka, odnosno može se pretpostaviti da se fiziološko opterećenje sudija mijenja kako se utakmica bliži kraju. Glavni cilj u ovom istraživanju bio je utvrditi postoje li statistički značajne razlike u fiziološkom opterećenju sudija s obzirom na period košarkaške utakmice.

METODE

Uzorak ispitanika

Uzorak ispitanika sastojao se od 31 sudije, prosječne dobi 33,35 ± 5,17 godina koji su se nalazili na A listi sudija I. Hrvatske košarkaške lige u takmičarskoj sezoni

The avarage hight of the referees was 186.34 ± 5.40 cm, and the avarage body mass was 88.04 ± 7.47 kg. Body mass index varied in the range of 21.80 to 29.80 kg/m² with the avarage value of 25.32 ± 1.60 kg/m². For the purpose of this research the level of maximum relative oxygen intake was determined using a standard protocol for estimating functional abilities, done in the Sports – diagnostic Centre of the Faculty of Kinesiology, University of Zagreb, which represents a progressive test of load on a moving carpet with standard inclination of 1,5% (spiroergometry method). The avarage value of maximum relative oxygen intake was 52.49 ± 5.80 ml/kg/min, with the range of results from 43.15 to 65.56 ml/kg/min. Values of the heart rate in rest have varied in the range of 42 to 86 beats/min with the avarage value of 66.22 beats/min.

The referee list was defined by the Croatian Basketball Referee Association, and it is made every year according to the results of officiating in the past regular season.

Sample of variables

The sample of variables consisted of the following: Fs - avarage heart rate; FSmax – maximum heart rate; E – energy consumption (kcal/min). The physiological load of the referees was followed by heart rate measuring during official basketball games of the 1st Croatian Basketball League in the season 2008/2009. The heart rate during a game was measured with a cardiotachometer (an electronic device for heart rate measuring), produced by *POLAR*, *model RS400* (Finland). Before the beginning of the game, cardiotachometers were put on the referees in the way that an electronic watch (a signal reciever) was placed around the wrist, and a band with the signal transmiter was placed around the chest beneath the official shirt. The electronic devices for heart rate measuring (cardiotachometers) were set in motion just before the beginning of the game. The devices were recordnig the heart rate in an interval of 5 seconds. The game was monitored by official and proffesional person who noted all time intervals during the game using a stop – watch. Every game was also monitored using a video camera which will later allow more quality and more precise analysis of the obtained data. At the end of the game, data from the electronic measuring device were transfered to the computer which enabled further data analysis using an adequate programme aplication (Polar Pro Trainer 5).

Methods of data processing

Data processing was done using a programme package STATISTICA for Windows, ver 8. The first

2008/2009. Prosječna visina sudija iznosila je 186,34 ± 5,40 cm, a prosječna masa 88,04 ± 7,47 kg. Indeks tjelesne mase kretao im se u rasponu od 21,80 do 29,20 kg/m², s prosječnom vrijednošću od 25,32 ± 1,60 kg/m². Za potrebe istraživanja utvrđen je i nivo maksimalnog relativnog prijema kiseonika putem standardnog protokola za procjenu funkcionalnih sposobnosti koji se provodi u Sportsko - dijagnostičkom centru Kineziološkog fakulteta Sveučilišta u Zagrebu, a predstavlja progresivni test opterećenja na pokretnom tepihu, uz konstantan nagib od 1,5% (spiroergometrijska metoda). Prosječna vrijednost maksimalnog relativnog prijema kiseonika iznosila je 52,49 ± 5,80 ml/kg/min, s rasponom rezultata od 43,15 do 65,56 ml/kg/min. Vrijednosti frekvencije srca u mirovanju kretale su se u rasponu od 42 do 86 otk/min, s prosječnom vrijednošću od 66,22 otk/min.

Lista sudija određena je od strane Udruge hrvatskih košarkaških sudaca, a sastavlja se svake godine prema rezultatima suđenja u prethodnoj takmičarskoj godini.

Uzorak varijabli

Uzorak varijabli činile su sljedeće varijable: Fs - prosječna frekvencija srca; Fsmax - maksimalna frekvencija srca; E – energetska potrošnja (kcal/min). Fiziološko opterećenje sudija praćeno je mjerenjem frekvencije srca za vrijeme službenih, takmičarskih košarkaških utakmica I. Hrvatske košarkaške lige u takmičarskoj sezoni 2008/2009. Frekvencija srca tokom utakmice mjerena je kardiotahometrom (elektronskim mjeračem frekvencije srca) proizvođača POLAR, *model* RS400 (Finska). Prije početka utakmice, sudijama su postavljeni elektronski mjerači frekvencije srca i to na način da se elektronski sat (prijemnik signala) postavio oko ručnog zgloba, a traka s odašiljačem signala oko grudnog koša ispod službene majice. Elektronski mjerači frekvencije srca pokrenuti su prije početka same utakmice. Mjerači frekvencije srca bilježili su frekvenciju srca u intervalu od 5 sekundi. Utakmicu je pratila službena i obučena osoba koja je bilježila sve vremenske intervale tokom utakmice, koristeći pri tome štopericu. Svaka utakmica praćena je i video kamerom kako bi se kasnije omogućila kvalitetnija i preciznija analiza dobijenih podataka. Na kraju utakmice podaci iz elektronskog mjerača frekvencije srca prebačeni su u računar što je omogućilo daljnju analizu dobijenih podataka putem odgovarajuće programske aplikacije (Polar Pro Trainer 5).

Metode obrade podataka

Obrada podataka izvršena je primjenom programskog paketa STATISTICA for Windows, ver 8. Prvi korak

TABLE 1

Basic statistic descriptive parameters of variables for estimating the physiological load of the referees while officiating basketball games

TABELA 1

Osnovni statistički deskriptivni parametri varijabli za procjenu fiziološkog opterećenja sudija tokom suđenja košarkaških utakmica .

ID	MU	*M*	*SD*	*MIN*	*MAX*
HR*M*1	beats/min	141.00	9.88	122.00	162.00
%HRmax1	%	75.60	5.13	67.58	87.79
E*M*min1	kcal	14.29	2.24	9.57	19.17
HRmin1	beats/min	108.87	12.03	79.00	133.00
HRmax1	beats/min	164.51	10.00	146.00	187.00
HR*M*2	beats/min	140.25	9.62	123.00	167.00
%HRmax2	%	75.19	4.78	67.34	85.46
E*M*min2	kcal	14.12	1.99	10.22	17.36
HRmin2	beats/min	110.83	12.62	90.00	145.00
HRmax2	beats/min	163.67	8.65	147.00	186.00
HR*M*3	beats/min	139.48	10.49	123.00	167.00
%HRmax3	%	74.77	5.17	63.26	85.46
E*M*min3	kcal	13.94	2.08	10.29	18.00
HRmin3	beats/min	106.32	11.87	83.00	123.00
HRmax3	beats/min	162.19	10.57	141.00	188.00
HR*M*4	beats/min	137.80	9.77	121.00	163.00
%HRmax4	%	73.88	4.91	61.73	83.72
E*M*min4	kcal	13.65	1.76	10.43	17.45
HRmin4	beats/min	109.58	12.07	90.00	139.00
HRmax4	beats/min	161.67	9.25	142.00	184.00
HR*M*1P	beats/min	139.93	9.41	122.00	164.00
%HRmax1P	%	75.08	4.81	68.13	86.62
E*M*min1P	kcal	14.03	2.03	9.78	17.93
HR*M*2P	beats/min	137.87	9.86	121.00	164.00
%HRmax1P	%	73.92	4.97	61.73	84.30
E*M*min1P	kcal	13.66	1.87	10.34	17.61

Legend: **ID** - Indicator (Pokazatelj); **MU** - Mesure unit (Jedinica mjere); ***M*** - Sample mean (Aritmetička sredina); ***SD*** - Standard deviation (Standardna devijacija); ***MIN*** - Minimum value (Najmanja vrijednost); ***MAX*** - Maximum value (Najveća vrijednost); **HR*M*1,2,3,4** – Avarage heart rate 1,2,3,4 – quarters (Prosječna frekvencija srca 1,2,3,4 četvrtina); **%HRmax1,2,3,4** – Total percentage of maximum heart rate 1,2,3,4 quarters (Ukupan postotak od maksimalne frekvencije srca 1,2,3,4 četvrtina); **E*M*min1,2,3,4** – Avarage energy consumption per minute 1,2,3,4 quarters (Prosječna energetska potrošnja u minuti 1,2,3,4 četvrtina); **HRmin1,2,3,4** – Lowest heart rate value 1,2,3,4 – quarters (Najmanja vrijednost frekvencije srca 1,2,3,4 četvrtina); **HRmax1,2,3,4** – Maximum heart rate value 1,2,3,4 – quarters (Najveća vrijednost frekvencije srca 1,2,3,4 četvrtina); **HR*M*1P** – Avarage heart rate in first half – time (Prosječna frekvencija srca u prvom poluvremenu); **%HRmax1P** – Total percentage of maximum heart rate in first half – time (Ukupan postotak od maksimalne frekvencije srca – prvo poluvrijeme); **E*M*min1P** – Avarage energy consumption per minute in first half – time (Prosječna energetska potrošnja u minuti - prvo poluvrijeme); **HR*M*2P** – Avarage heart rate in second half – time (Prosječna frekvencija srca u drugom poluvremenu); **%HRmax2P** – Total percentage of maximum heart rate in second half – time (Ukupan postotak od maksimalne frekvencije srca – drugo poluvrijeme); **E*M*min2P** – Avarage energy consumption per minute in second half - time (Prosječna energetska potrošnja u minuti - prvo poluvrijeme); Beats/min - Otk/min.

step in data processing was to calculate central and dispersive paramters for all variables. For each variable the following parameters were calculated: mean (*M*), standard deviation (*SD*), minimum value (*MIN*), maximum value (*MAX*).

Statistical difference significance between particular parts of the game in variables for estimating the physiological load, were tested using univariate variance analysis (ANOVA).

RESULTS AND DISCUSSION

The obtained results from Table 1 show that in the first quarter the avarage heart rate amounted 141 ± 9.88 beats/min, which is in avarage 75.60 ± 5.13% of the maximum heart rate. The avarage value of heart rate moved in the range of 122 to 162 beats/min, while the highest measured value during first quarter was 187 beats/min. The avarage energy consumption during first quarter was 14.29 ± 2.24 kcal/min.

In the second quarter the avarage heart rate was 140.25 ± 9.62 beats/min, which is in avarage 75.19 ± 4.78% of the maximum heart rate. The avarage value of heart rate in second quarter moved in the range of 123 to 167 beats/min, while the highest measured value of the heart rate was 186 beats/min. The avarage energy consumption was 14.12 ± 1.99 kcal/min.

During the third quarter the avarage heart rate amounted 139.48 ± 10.49 beats/min, in the range of avarage values of 123 beats/min (the lowest value) to 167 beats/min (the highest value). The obtained avarage heart rate value matches the value of 74.77 ± 5.17% from the calculated maximum heart rate. The highest measured value of the heart rate in third quarter was 188 beats/min, while the avarage energy consumption was 13.94 ± 2.08 kcal/min.

During the fourth quarter the measured avarage heart rate value amounted 137.80 ± 9.77 beats/min, with the lowest avarage value of 121 beats/min and the highest value of 163 beats/min. The obtained avarage heart rate value in the last quarter matches the value of 73.88 ± 4.91% of the maximum heart rate. The highest noted heart rate value in the last quarter was 184 beats/min, while the avarage energy consumption amounted 13.65 ± 1.76 kcal/min.

The avarage heart rate in first half – time (first and second quarter and break between them) amounted 139.93 ± 9.41 beats/min, which matches the value of 75.08 ± 4.81% of the maximum heart rate. The avarage maximum heart rate value during first half – time amounted 166.12 ± 9.73 beats/min, and

u obradi podataka bio je izračunati centralne i disperzivne parametre za sve varijable. Za svaku varijablu izračunati su sljedeći parametri: aritmetička sredina (AS), standardna devijacija (SD), najmanja vrijednost (MIN), najveća vrijednost (MAX).

Statistička značajnost razlika između pojedinih dijelova utakmice u varijablama za procjenu fiziološkog opterećenja testirana je univarijatnom analizom varijanse (ANOVA).

REZULTATI I DISKUSIJA

Dobijeni rezultati u Tabeli 1 pokazuju da je u prvoj četvrtini prosječna frekvencija srca iznosila 141 ± 9,88 otk/min, što je u prosjeku 75,60 ± 5,13% od maksimalne frekvencije srca. Prosječna vrijednost frekvencije srca kretala se u rasponu od 122 do 162 otk/min, dok je najveća izmjerena vrijednost za vrijeme prve četvrtine iznosila 187 otk/min.

Prosječna energetska potrošnja tokom prve četvrtine bila je 14,29 ± 2,24 kcal tokom jedne minute.

U drugoj četvrtini prosječna frekvencija srca iznosila je 140,25 ± 9,62 otk/min što je u prosjeku 75,19 ± 4,78% od maksimalne frekvencije srca. Prosječna vrijednost frekvencije srca u drugoj četvrtini kretala se u rasponu od 123 do 167 otk/min, dok je najveća izmjerena vrijednost frekvencije srca iznosila 186 otk/min. Prosječna energetska potrošnja u drugoj četvrtini bila je 14,12 ± 1,99 kcal tokom jedne minute.

Za vrijeme treće četvrtine, prosječna frekvencija srca iznosila je 139,48 ± 10,49 otk/min, u rasponu prosječnih vrijednosti od 123 otk/min (najmanja vrijednost) do 167 otk/min (najveća vrijednost). Dobijena prosječna vrijednost frekvencije srca odgovara vrijednosti od 74,77 ± 5,17% od izračunate maksimalne frekvencije srca. Najveća izmjerena vrijednost frekvencije srca u trećoj četvrtini iznosila je 188 otk/min, dok je prosječna energetska potrošnja bila 13,94 ± 2,08kcal tokom jedne minute.

Tokom četvrte četvrtine izmjerena prosječna vrijednost frekvencije srca iznosila je 137,80 ± 9,77 otk/min, s najmanjom prosječnom vrijednošću od 121,00 otk/min, te najvećom od 163 otk/min. Dobijena prosječna vrijednost frekvencije srca u četvrtoj četvrtini odgovara vrijednosti od 73,88 ± 4,91% od maksimalne frekvencije srca. Najveća zabilježena vrijednost frekvencije srca u četvrtoj četvrtini bila je 184 otk/min, dok je prosječna energetska potrošnja iznosila 13,65 ± 1,76 kcal tokom jedne minute.

Prosječna frekvencija srca u prvom poluvremenu (prva i druga četvrtina i odmor između njih) iznosila je 139,93 ± 9,41 otk/min što odgovara vrijednosti od

the avarage energy consumption amounted 14.03 ± 2.03 kcal/min.

Similar results were obtained during second half – time (third and fourth quarte and break between them), where the avarage heart rate value amounted 137.87 ± 9.86 beats/min. The obtained avarage heart rate value matches the value of 73.92 ± 4.97% of the maximum heart rate. The avarage maximum heart rate value during second half – time amounted 164.16 ± 9.69 beats/min and the avarage energy consumption amounted 13.66 ± 1.87 kcal/min.

Statistical difference significance between particular parts of the game in variables for estimating the physiological load were tested using the univariate analysis of variance (ANOVA).

Based on the obtained data of univariate variance analysis (Table 2) it is concluded that there is no statistically significant shift between first (first and second quarter and break between them) and second half – time (third and fourth quarter and break between them) of the basketball game in the variables for estimating the level of physiological load: FS - avarage heart rate ($F = .710$, $p = .402$); Fsmax – maximum heart rate ($F = .636$, $p = .428$); E – energy consumption ($F = .561$, $p = .456$); with the level of significance of .05.

Therefore, in second half – time the values of energy consumption, avarage heart rate and maximum heart rate are somewhat lower, however the differences are not statistically significant at the level of significance of .05.

Although, the values of central parameters of avarage and maximum heart rate as well as the energy consumption, are gradually reduced as the game is coming to an end. From the obtained data of univariate variance analysis (Table 3) it can be seen that there are no statisically significant differences between particular periods (quarters) in the level of physiological load of the referees during the game. In other words, the obtained statistic results show that variability between the groups is not significantly bigger than variability within the groups at the level of significance of .05.

Based on the obtained data of the relative maximum oxygen intake it can be concluded that the referees have a well developed aerobic capacity (Leicht, 2007), similar to professional basketball players (Castagna, Chaouachi, Rampinini, Chamari, & Impellizzeri, 2009) and the referees from other team sports (Casajus & Castagna, 2007; Castagna & D'Ottavio, 2001; Krustup & Bangsbo, 2001).

The obtained data are pointing out to a high physiological load which doesn't statistically significant

75,08 ± 4,81% od maksimalne frekvencije srca. Prosječna maksimalna vrijednost frekvencije srca tokom prvog poluvremena iznosila je 166,12 ± 9,73 otk/min, a prosječna energetska potrošnja 14,03 ± 2,03 kcal/min.

Slični rezultati dobijeni su i tokom drugog poluvremena (treća i četvrta četvrtina i odmor između njih) gdje je prosječna vrijednost frekvencije srca iznosila 137,87 ± 9,86 otk/min. Dobijena prosječna vrijednost frekvencije srca odgovara vrijednosti od 73,92 ± 4,97% od maksimalne frekvencije srca. Prosječna maksimalna vrijednost frekvencije srca tokom drugog poluvremena iznosila je 164,16 ± 9,69 otk/min, a prosječna energetska potrošnja 13,66 ± 1,87 kcal/min.

Statistička značajnost razlika između pojedinih dijelova utakmice u varijablama za procjenu fiziološkog opterećenja testirana je univarijatnom analizom varijanse (ANOVA).

Na temelju dobijenih rezultata univarijatne analize varijanse (Tabela 2) zaključuje se da ne postoji statistički značajno odstupanje između prvog (prva i druga četvrtina i odmor između njih) i drugog poluvremena (treća i četvrta četvrtina i odmor između njih) košarkaške utakmice u varijablama za procjenu nivoa fiziološkog opterećenja (FS - prosječna frekvencija srca ($F = 0,710$, $p = 0,402$); Fsmax - maksimalna frekvencija srca ($F = 0,636$, $p = 0,428$); E – energetska potrošnja ($F = 0,561$, $p = 0,456$); pri nivou značajnosti od 0,05.

Dakle, u drugom poluvremenu vrijednosti energetske potrošnje, prosječne frekvencije srca, te maksimalne frekvencije srca jesu nešto niže, međutim razlike nisu statistički značajne pri nivou značajnosti od 0,05.

Iako se vrijednosti centralnih parametara prosječne i maksimalne frekvencije srca, kao i energetske potrošnje postepeno smanjuju kako se bliži kraj utakmice, iz dobijenih rezultata univarijatne analize varijanse (Tabela 3) vidljivo je da ne postoje statistički značajne razlike između pojedinih perioda (četvrtina) u nivou fiziološkog opterećenja sudija tokom suđenja, odnosno dobijeni rezultati govore da varijabilitet između grupa nije statistički značajno veći od varijabiliteta unutar grupa pri nivou značajnosti od 0,05.

Na osnovu dobijenih rezultata relativnog maksimalnog prijema kiseonika, može se zaključiti da sudije imaju dobro razvijen aeroban kapacitet (Leicht, 2007), sličan vrhunskim košarkašima (Castagna, Chaouachi, Rampinini, Chamari i Impellizzeri, 2009) i sudijama iz drugih kolektivnih sportova (Casajus i Castagna, 2007; Castagna i D'Ottavio, 2001; Krustup i Bangsbo, 2001).

Dobijeni rezultati ukazuju na visoko fiziološko opterećenje koje se statistički značajno ne mijenja kod

TABLE 2

Testing of differences between first and second half – times of basketball games in variables for estimating the level of physiological load of the referees while officiating – univariate variance analysis (ANOVA).

TABELA 2

Testiranje razlika između prvih i drugih poluvremena košarkaških utakmica u varijablama za procjenu nivoa fiziološkog opterećenja sudija tokom suđenja – univarijantna analiza varijance (ANOVA).

Variables	1st half-time		2nd half time		*F*	*p*
	M	*SD*	*M*	*SD*		
HR*M*	139.93	9.41	137.87	9.86	.710	.402
HRmax	166.12	9.73	164.16	9.69	.636	.428
E kcal/min	14.03	2.03	13.66	1.87	.561	.456

Legend: 1st half–time, first and second quarter and break between them - 1. poluvrijeme, prva i druga četvrtina i odmor između njih; 2nd half–time, third and fourth quarter and break between them - 2. poluvrijeme, treća i četvrta četvrtina i odmor između njih; **HR*M*** - Avarage heart rate (Prosječna frekvencija srca); **HRmax** – Maximum heart rate (Maksimalna frekvencija srca); **E** – Energy consumption (Energetska potrošnja); ***M*** - Sample mena (Aritmetička sredina); ***SD*** - Standard deviation (Standardna devijacija); ***F*** - *F*-ratio (*F*-test); ***p*** – Probability (Vjerovatnoća).

TABLE 3

Testing of differences between first and second half – times of basketball games in variables for estimating the level of physiological load of the referees while officiating – univariate variance analysis (ANOVA).

TABELA 3

Testiranje razlika između perioda (četvrtina) košarkaških utakmica u varijablama za procjenu nivoa fiziološkog opterećenja sudija tokom suđenja - univarijantna analiza varijance (ANOVA).

Varibales	1st quarter		2nd quarter		3rd quarter		4th quarter		*F*	*p*
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*		
HRM	141.00	9.88	140.25	9.62	139.48	10.49	137.80	9.77	.586	.625
HRmax	164.51	10.00	163.67	8.65	162.19	10.57	161.67	9.25	.572	.634
E kcal/min	14.29	2.24	14.12	1.99	13.94	2.08	13.65	1.76	.569	.636

Legend: Quarter - Četvrtina; **HRmax** – Maximum heart rate (Maksimalna frekvencija srca); **E** – Energy consumption (Energetska potrošnja); ***M*** - Sample mena (Aritmetička sredina); ***SD*** - Standard deviation (Standardna devijacija); ***F*** - *F*-ratio (*F*-test); ***p*** – Probability (Vjerovatnoća).

change at well prepared referees concidering the period of the game.

In view of proven high physiological load which results from dynamics of the game of basketball, it can be assumed that physical – motor preparation of the referees is of high importance to their quality of officiating.

Research results fold over with results obtained in other researches of physiological load of the referees during basketball games. Thus, Leicht in his researches noted the vales of heart rate during a game between 130 and 150 beats/min, or 73-79% of the maximum heart rate. More than 63% of the time

dobro pripremljenih sudija s obzirom na period same utakmice.

S obzirom na dokazano visoko fiziološko opterećenje, a koje proizlazi iz dinamičnosti košarkaške igre, može se pretpostaviti da je kondiciono-motorička pripremljenost sudija od velike važnosti za kvalitet njihovog suđenja.

Rezultati istraživanja poklapaju se s dobijenim rezultatima u drugim istraživanjima fiziološkog opterećenja sudija tokom košarkaških utakmica. Tako je Leicht u svojim istraživanjima zabilježio vrijednosti frekvencije srca tokom suđenja između 130 i 150 otkucaja u minuti, ili 73–79% od maksimalne frekvencije srca. Više od 63% vremenskog intervala utakmice sudije su proveli u intenzitetu opterećenja većem od

interval the referees spent in an intensity load higher than 70% of the maximum heart rate. Based on these results it was concluded that the referees are exposed to high level activities during an entire game (Leicht, 2004, 2008). In the research of Rupcic (2010), based on the obtained heart rate values during officiating basketball games and heart rate values at anaerobic threshold, it was concluded that basketball referees spent 50% of an overall game time in the zones of high aerobic load. Taking into consideration only the quarters, without the breaks between them, that percentage amounts up to 60%. Considering the time spent in particular intensity zone, and also the energy consumption values, it was concluded that the referees, while officiating a game, are exposed to high physiological load (Ibid).

Similar results were also obtained in other team sports such as football and rugby (Barbero Alvarez, Boullosa, Nakamura, Andrin, & Castagna, 2012; Catterall, Reilly, Atkinson, & Coldwells, 1993; D´Ottavio & Castagna, 2001; Martin, Tolfrey, Smith, & Jones, 2005). Although significant differences in avarage heart rate values between first and second half - time weren't determined, there are however certain variations. That's how D'ottavio and Castagna (2001) noticed that cardiovascular system load of the italian Series A referees, was lower in first 15 minutes of the first half – time, while Helsen and Bultynck (2004) noticed significant variations of heart rate during important games. The lowest heart rates were measured in first 15 minutes of both half – times, and the highest in last 15 minutes also in both half – times. This increase at the end of half – times, authors link to an increased effort of the referees in keeping up with the game rate. There are many other factors which influence the change in heart rate besides the intensity of the game, such as dehydration, thermal stress, psychological stress, high intensity activities.

CONCLUSION

With concideration to determined high physiological load of the referees during an entire basketball game, it is logical to conclude that the referees must have optimally developed physical – motor preparation. Otherwise they wouldn't be able to follow dynamic movement of the players and accordingly complexed game situations, which in the end would result in bad, not precise enough estimation of game situations. All of the stated would directly result to the outcome of the game itself. That observation comes out of the fact that bad physical – motor preparation influences on a faster show of weariness, which will ultimately result in considerable reduction

70% od maksimalne frekvencije srca. Na osnovu tih rezultata, zaključeno je da su sudije tokom cijele utakmice izloženi aktivnostima visokog intenziteta. (Leicht, 2004, 2008). U istraživanju Rupčića (2010) na temelju dobijenih vrijednosti frekvencije srca tokom suđenja košarkaških utakmica i vrijednosti frekvencije srca pri anaerobnom ventilacijskom pragu, zaključeno je da košarkaške sudije 50% od ukupnog trajanja košarkaške utakmice provode u zonama srednjeg do visokog aerobnog opterećenja, a ukoliko se uzmu u obzir samo četvrtine, bez odmora između njih, tada taj postotak iznosi i do 60%. Uzevši u obzir provedeno vrijeme u pojedinoj zoni intenziteta, ali i vrijednosti energetske potrošnje tokom utakmice, zaključeno je da su sudije tokom suđenja izloženi visokom fiziološkom opterećenju (Ibid).

Slični su rezultati dobijeni i u nekim drugim timskim sportovima, kao što su fudbal i ragbi (Barbero Alvarez, Boullosa, Nakamura, Andrin i Castagna, 2012; Catterall, Reilly, Atkinson i Coldwells, 1993; D´Ottavio i Castagna, 2001; Martin, Tolfrey, Smith i Jones, 2005). Iako nisu utvrđene značajne razlike u prosječnim vrijednostima frekvencije srca sudija između prvog i drugog poluvremena, ipak postoje određene varijacije. Tako su D'Ottavio i Castagna (2001) uočili da je opterećenje kardiovaskularnog sistema sudija talijanske Serie A bilo niže tokom prvih 15 minuta prvog poluvremena, dok su Helsen i Bultynck (2004) uočili značajne varijacije frekvencije srca tokom važnih utakmica. Najniže su frekvencije izmjerene tokom prvih 15 minuta u oba poluvremena, a najviše u posljednjih 15 minuta, također u oba poluvremena. Ovo povećanje pri kraju poluvremena autori povezuju s povećanim naporom sudija pri praćenju tempa utakmice. Na promjene frekvencije srca, pored intenziteta same igre, utiče i niz drugih faktora, kao što su dehidracija, termalni stres, psihološki stres, aktivnosti visokog intenziteta.

ZAKLJUČAK

S obzirom na utvrđeno visoko fiziološko opterećenje sudija tokom cijele košarkaške utakmice, logično je zaključiti da sudije moraju imati optimalno razvijenu kondiciono-motoričku pripremljenost. U suprotnom, sudije neće biti u stanju pratiti dinamične kretnje igrača, shodno tome i složene situacije tokom igre što će u krajnjem slučaju rezultirati lošom, odnosno nedovoljno preciznom procjenom situacije na terenu, a koja će direktno uticati na rezultat (ishod) same utakmice. Ta konstatacija proizlazi iz činjenice da lošija kondiciono-motorička pripremljenost utiče na bržu pojavu umora, što će kod sudija rezultirati znatno smanjenim nivoom koncentracije u trenutku, tj. u

of concentration in the given moment, which implies a very short time interval when it is necessary to form a judgement about a specific game situation. Of course, good physical – motor preparation of the referees is only one of the prerequisites for quality officiating. It can be assumed that experience in officiating, theoretical knowledge and feeling for the game are certainly additional factors which influence the quality of every referee.

izrazito kratkom vremenskom intervalu kada je potrebno prosuditi određenu situaciju tokom igre. Naravno, dobra kondiciono-motorička pripremljenost sudija samo je jedan od preduslova za kvalitetno suđenje. Može se pretpostaviti da su iskustvo u suđenju, teorijsko znanje i osjećaj za igru svakako dodatni faktori koji utiču na kvalitet suđenja svakog sudije.

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DIE UNTERSCHIEDE IN DER PHYSIOLOGISCHEN BELASTUNG DER SCHIEDSRICHTER IN BEZUG AUF DIE DAUER EINES BASKETBALLSPIELS

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Wie die Spieler, sind auch die Schiedsrichter ein wichtiger Bestandteil jedes Basketballspiels. Das Endergebnis der meisten Basketballspiele wird in den letzten Momenten entschieden, wenn das Niveau der konditionellen und motorischen Leistungsbereitschaft, die psychische Stabilität und der Taktikwechsel des Teams, beträchtlich auf die Zahl der begangenen technischen und taktischen Fehler und Fehler die aus der Missachtung der Spielregeln entstehen, Einfluss hat. Damit die Entscheidung des Richters so gut und korrekt wie möglich getroffen wird, muss der Schiedsrichter während des Spiels immer an der richtigen Stelle sein und einen guten Überblick haben. Dies verlangt eine ausgezeichnete konditionelle Leistungsbereitschaft des Schiedsrichters, aber auch gute visuelle Wahrnehmung, mentale Fähigkeit, fokussierte Aufmerksamkeit, die Bereitschaft und die Fähigkeit schnelle Entscheidungen zu treffen.

Die Schiedsrichter sind während des Richtens des ganzen Spiels unter großer Belastung, aber vor allem in den letzten Momenten, wenn ihre Aktivität, im Sinne der wachsenden Zahl der getroffen Entscheidungen, ansteigt. Man kann also annehmen, dass sich die physiologische Belastung der Schiedsrichter ändert, wie sich das Spiel dem Ende nähert.

Das Hauptziel dieser Forschung war festzustellen, ob es in der physiologischen Belastung der Schiedsrichter, im Bezug auf die Dauer des Basketballspiels, statistisch wichtige Unterschiede gibt. Es wurden 31 Schiedsrichter, im Durchschnittsalter von 33,35 ± 5.17, aus der A-Liste der Schiedsrichter der I. kroatischen Basketball Liga in der Spielsaison 2008/2009, getestet. Die Durchschnittsgröße der Schiedsrichter betrug 186.34 ± 5.40 cm, und das Durchschnittsgewicht 88.04 ± 7.47 kg. Der Körpermassenindex variierte zwischen 21.80 zu 29.20 kg/m², mit durchschnittlich 25,32 ± 1,60 kg/m². Aus Forschungsgründen wurde die relative maximale Sauerstoffaufnahme, mittels des Standardprotokolls für die Bewertung der funktionellen Fähigkeiten, das im Zentrum für Sportdiagnostik der Kinesiologischen Universität in Zagreb durchgeführt wird, festgestellt. Dies ist ein progressiver Belastungstest auf dem Laufband mit konstanter Neigung von 1.5 % (spiroergometrische Methode). Die durchschnittliche relative maximale Sauerstoffaufnahme betrug 52.49 ± 5.80 ml/kg/min, mit Ergebnissen in der Spanne von 43.15 bis 65.56 ml/kg/min.

Die der Herzfrequenzwerte im Ruhezustand variierten zwischen 42 und 86 Schläge/Min, mit durchschnittlich 66.22 Schläge/Min.

Folgende Variablen sind im Muster: FSM - *durchschnittliche Herzfrequenz*; FSmax – *maximale Herzfrequenz*; E - *Energieverbrauch* (kcal/min). Die Messungen wurden während der offiziellen Wettbewerbsspiele der I. kroatischen Basketball Liga in der Spielsaison 2008/2009 durchgeführt. Die Herzfrequenz während des Spiels wurde mit einem Kardiotachometer (einem elektronischen Herzfrequenzmessgerät) des Herstellers POLAR, Modell RS400 (Finnland).

Die Daten wurden mit Hilfe des Programmpakets STATISTICA for Windows, ver 8 bearbeitet. Für jede Variabel wurden die folgenden Parameter berechnet: das arithmetische Mittel (AS), die Standardabweichung (SD), der Minimalwert (MIN), der Maximalwert (MAX). Die statistische Wichtigkeit der Unterschiede zwischen den verschiedenen Teilen des Spiels in Variablen für die Bewertung der physiologischen Belastung wurde mit der univariaten der Varianzanalyse (ANOVA) getestet. Aufgrund des Resultats der univariaten der Varianzanalyse kommt man zum Schluss, dass es keine statistisch wichtigen Unterschiede in der physiologischen Belastung zwischen der ersten und zweiten Halbzeit, sowie den einzelnen Viertel eines Basketballspiels gibt.

Hinsichtlich der festgestellten hohen physiologischen Belastung der Schiedsrichter während des Basketballspiels kann man den logischen Schluss ziehen, dass die Schiedsrichter eine optimal entwickelte konditionelle und motorische Leistungsbereitschaft haben müssen. Ansonsten wären die Schiedsrichter nicht in der Lage die dynamischen Bewegungen der Spieler und die komplizierten Situationen während des Spiels zu verfolgen, was im Endeffekt eine schlechte, unpräzise Beurteilung der Situation auf dem Spielfeld zur Folge hat und direkten Einfluss auf das Spielresultat hat. Dieser Schluss wird aus dem Fakt gezogen, dass eine schlechte konditionelle und motorische Leistungsbereitschaft auf schnelleres Ermüden Einfluss hat, was bei den Schiedsrichtern zu eingeschränkter Konzentration in der kurzen Zeit, in der eine Situation während des Spieles zu Beurteilen ist, führt. Natürlich ist gute konditionelle und motorische Leistungsbereitschaft der Schiedsrichter eine der Voraussetzungen für gutes Richten. Es ist anzunehmen, dass Erfahrung im Richten, theoretisches Wissen und Gefühl für das Spiel, auf jeden Fall, weitere Faktoren sind, die auf die Qualität der Schiedsrichter Einfluss hat.

Schlüsselworte: konditionelle und motorische Leistungsbereitschaft, Herzfrequenz, Energieverbrauch

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POVEZANOST INDEKSA I VARIJABLI REZULTATSKE USPJEŠNOSTI U REKREATIVNOM STONOM TENISU

CORRELATION BETWEEN THE INDEX AND EFFICIENCY INDICATORS OF SUCCESS IN RECREATION TABLE TENNIS

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SUMMARY

Amongst different methods of quality analysis of the table tennis player's game, the basic idea of this study was to detect those indicators (data) for collection of which only the final result in particular competitions in a larger number of events, of one game, or certain sets in one table tennis game would be sufficient. The basic aim of the research is to establish to what extent the indexes and variables derived directly from the results of individual table tennis games could predict indexes which are described by the final result for an individual in a larger number of individual table tennis games. The research involves an analysis of an intentional sample of 956 table tennis players competing in various leagues during 2007. Results show that correlations between individual variables of the table tennis competitors' efficiency are statistically significant. The correlations between indexes of the competitor's efficiency are also statistically significant. In particular, we found positive (and significant) correlations between all the direct and indirect indicators of players' efficacy (medium strongly to strongly correlated). The correlation between individual variables and indexes of the table tennis competitor's efficiency, with the total efficacy index, are statistically significant. It can be concluded that all the indexes and variables can describe specific aspects of the performance in table tennis, predicting total efficacy of the players.

Key words: analysis, competition, prediction, racquet sports.

SAŽETAK

Među različitim metodama analize kvaliteta igre stonotenisera, osnovna ideja ovog istraživanja bila je utvrditi one indikatore (podatke) za čije je prikupljanje dovoljan samo konačni rezultat u određenim takmičenjima u većem broju događaja: stonoteniskih mečeva ili setova. Glavni cilj istraživanja je utvrđivanje u kojem obimu indeksi i varijable izvedene direktno iz rezultata pojedinačnih susreta mogu predvidjeti indekse koji su izvedeni iz konačnog rezultata pojedinca u većem broju pojedinačnih mečeva. Istraživanje uključuje analizu namjernog uzorka od 956 stonotenisera, koji su se takmičili na različitim ligaškim nivoima tokom 2007. Rezultati pokazuju da su korelacije između pojedinačnih varijabli koje su pokazatelji stonoteniserove uspješnosti statistički značajne. Korelacije između indeksa stonoteniserove uspješnosti su takođe statistički značajne. Takođe, pronašli smo pozitivne (i statistički značajne) korelacije između svih direktnih i indirektnih pokazatelja stonoteniserove uspješnosti (osrednje visoke do visoke povezanosti). Povezanost između pojedinačnih varijabli i indeksa stonoteniserove efikasnosti, s indeksom ukupne uspješnosti, statistički su značajne. Može se zaključiti da svi indeksi i varijable tumače specifične aspekte stonoteniserove uspješnosti, prognozirajući ukupnu uspješnost stonotenisera.

Ključne riječi: analiza, takmičenje, prognoza, igre sa reketom.

INTRODUCTION

Besides in technical field, table tennis is also demanding in terms of tactical knowledge, technical skills, motor abilities and morphological characteristics, as well as appropriate conative characteristics necessary for a successful competition achievement (Grujić, 1975; Hudetz, 1982). Notational analysis is used by coaches and sport scientists to gather objective data on the performance of athletes. Systems for notational analysis are becoming increasingly sophisticated, reflecting the demands of coaches and scientists, as well as improvements in technology (Hughes & Franks, 1997). In any sporting situation, especially table tennis, it is difficult, if not impossible, for coaches to notice and remember all the key events occurring within a training session or match, equipped only with their knowledge of the sport in question and their powers of observation. Yet, analysis based on accurate observation and recall is a key tool for improving future performance of table tennis players. In table tennis notational analysis is an objective way of recording the performance of the player, so that critical events in that performance can be quantified in a consistent and reliable manner. Table tennis is one of the fastest ball games in the world, it is therefore difficult for the coach to notice and remember all the key elements occurring within a game or training session. Franks and Miller (1991) have highlighted memory retention problems, with coaches able to recall only 30-50% of key performance factors they had witnessed, even with special training in observation. However, as in many other sports branches, in table tennis analysis based on accurate observation and recall is a prime tool for improving future performance of the player. Table tennis is one of the sports branches that still have little research or real analysis, compared to sports branches like tennis or badminton. When we consult scientific data, we care about details and how we can transfer it in to our own practices, or how we can use it in any way. The most accurate observation is simple analysing of result in table tennis game. We have chosen exactly such approach.

The basic question which is set by the professionals aiming to improve result effect of sportsmen or teams in different sports branches is – how to assess the game quality (Brčić, Viskić Štalec, & Jaklinović Fressl, 1997). Amongst different manners of quality analysis of the table tennis player's game, the basic idea of research was to detect those indicators (data) for collection of which only the final result in particular competitions in larger number of events, in one table tennis match, certain sets in one table tennis match could be sufficient. Sindik (1999) performed that by

UVOD

Uz područje tehnike, stoni tenis je zahtjevan podjednako i u odnosu na potrebna taktička znanja, tehnička znanja, motoričke sposobnosti i morfološka obilježja, kao i za odgovarajuće konativne karakteristike potrebne za uspješna postignuća u takmičenju (Grujić, 1975; Hudetz, 1982). Notacijsku analizu koriste treneri i sportski naučnici za prikupljanje objektivnih podataka o vještini sportista. Sistemi za notacijsku analizu postaju sve sofisticiraniji, odražavajući zahtjeve trenera i naučnika, kao i za poboljšanja u tehnologiji, ponajprije onoj kojoj je svrha zabilježiti sve relevantne takmičarske situacije u stonom tenisu (Hughes i Franks, 1997). U svakoj sportskoj situaciji, naročito u stonom tenisu, treneru je teško, ako ne i nemoguće, uočiti i zapamtiti sve ključne događaje koji se javljaju unutar treninga ili meča, ako se oslanja isključivo na svoje znanje o sportu i vlastitu vještinu posmatranja. Ipak, analiza na temelju tačnih zapažanja i prisjećanja je ključni alat za poboljšanje buduće igre stonotenisera. U stonom tenisu notacijska analiza je objektivan način snimanja igre igrača, tako da se kritični događaji u toj performansi mogu kvantifikovati na dosljedan i pouzdan način. Stoni tenis je jedna od najbržih igara s loptom na svijetu, pa je za trenera teško uočiti i zapamtiti sve ključne elemente koji se javljaju unutar igre ili treninga. Franks i Miller (1991) istakli su probleme zadržavanja u pamćenju, s trenerima koji su u stanju prisjetiti se samo 30-50% od ključnih faktora koje uočavaju, čak i uz posebno obučavanje u posmatranju. Međutim, kao i u mnogim drugim sportskim granama, u stonom tenisu je analiza zasnovana na posmatranju i tačnom podsjećanju glavni alat za poboljšanje budućih rezultata igrača. Stoni tenis je jedna od sportskih grana u kojem je još uvijek relativno malo istraživanja ili objektivnih analiza u odnosu na sportske grane kao što su tenis ili badminton. Uvidom u naučne podatke, bitni su nam detalji i kako ih možemo prenijeti u vlastitu praksu, ili kako ih možemo koristiti na bilo koji način. Najpreciznije posmatranje je jednostavna analiza rezultata u stonoteniskom meču. Mi smo odabrali upravo takav pristup.

Osnovno pitanje koje je postavljeno od strane profesionalaca s ciljem poboljšanja rezultata efikasnosti sportista ili timova u raznim sportskim granama jeste kako procijeniti kvalitet igre (Brčić, Viskić Štalec i Jaklinović Fressl, 1997). Među različitim načinima analize kvaliteta stonoteniserove igre, osnovna ideja istraživanja bila je otkriti one pokazatelje (podatke) za prikupljanje kod kojih je dovoljan samo konačni rezultat (u pojedinim takmičenjima u većem broju

implementation of variables which could directly be derived from the results of competitions, however, those variables one could reduce to a smaller number of indexes. In the world of table tennis, some studies can be found, but in general there is a lack of literature for this discipline (Baca, Baron, Leser, & Kain, 2004; Đokić, 2008; Leser & Baca, 2009; Sindik, 1999; Sindik & Vidak, 2009; Wilson & Barnes, 1998; Wu Xiao & Escobar-Vargas, 2007). Due to these facts, this work seeks to establish written support for future studies on this sport based on the research carried out by the authors, the references cited, and information collected from racket sports in general.

The basic aim of the study is to establish to what extent indexes directly derived from the results of individual table tennis games could predict indexes that are described by the final result of an individual in a larger number of individual table tennis games. This kind of analysis could potentially be useful for the requirements of future planning for individual player training. *The goals* of the research are to determine: the correlation between individual variables of a table tennis competitors' efficiency (1); the correlation between indexes of efficiency, derived by summarizing several particular indexes (2); the correlation between individual variables of a table tennis competitors' efficiency, with the total efficacy index (3); the capacity for index and variable prognosis: game index, set index, games won, sets won, total efficacy index, on the basis of other indexes and variables of table tennis game efficiency and log variables (4).

In previous studies (Sindik, 1999; Sindik & Juričević, 2007) we found that most of the intercorrelations between the indexes and intercorrelations between the variables of a table tennis player's efficacy were intermediately to medium strongly correlated. Statistically significant predictive value of the indicators used was determined for the prognosis of direct indicators of efficiency, on the basis of other indexes and variables. We can generally assume that all the indexes and the total efficacy index of a table tennis competitors' efficiency are statistically significantly correlated with a performance success. Consequently, indexes and variables of final competition success can be predicted by all the variables and indexes of competitors' efficiency.

METHODS

Sample Entity

A final sample of 956 table tennis players competing during 2007 in various recreational table tennis leagues in SOKAZ, which played in leagues, ranked from 1 to 20, with a minimum of 33 to a maximum of 63 players in each league. In the final sample we selected

događaja, u stonoteniskom meču ili određenim setovima u stonoteniskom meču). Sindik (1999) daje pregled varijabli koje se direktno mogu izvesti iz rezultata takmičenja, međutim, ove varijable se mogu svesti na manji broj indeksa. U svijetu stonog tenisa, mogu se pronaći neke studije, ali, generalno, postoji manjak literature iz ove oblasti (Baca, Baron, Leser i Kain, 2004; Đokić, 2008; Leser i Baca, 2009; Sindik, 1999; Sindik i Vidak, 2009; Wilson i Barnes, 1998; Wu Xiao i Escobar-Vargas, 2007). Zbog te činjenice, ovaj rad nastoji dati podršku za buduće studije u ovoj sportskoj grani, na osnovu istraživanja provedenog od strane autora, koje bi se moglo provesti i kod ostalih sportskih grana s reketom.

*Osnovni cilj i*straživanja je utvrditi u kojoj se mjeri indeksima direktno izvedenim iz rezultata takmičenja u stonom tenisu mogu predvidjeti indeksi koji opisuju konačan rezultat pojedinca u većem broju pojedinačnih stonoteniskih susreta. Potencijalno, ova vrsta analize može biti korisna za potrebe budućeg planiranja treninga za pojedine igrače. *Ciljevi* istraživanja su utvrditi korelaciju između pojedinih varijabli takmičarske efikasnosti (1), utvrditi korelaciju između indeksa efikasnosti, izvedenih sumiranjem nekoliko posebnih varijabli (2), utvrditi korelaciju između pojedinačnih varijabli takmičarske efikasnosti u stonom tenisu, s ukupnim indeksom efikasnosti (3), utvrditi mogućnost prognoze indeksa i varijabli: indeks mečeva, indeks setova, ukupni indeks efikasnosti na osnovu ostalih indeksa i varijabli takmičarske efikasnosti u stonom tenisu i zapisničkih varijabli (4).

U prethodnim studijama (Sindik, 1999, Sindik i Juričević, 2007) utvrdili smo da je većina interkorelacija između indeksa i interkorelacija između varijabli takmičarske efikasnosti u stonom tenisu bila umjereno visoka. Statistički značajna prediktivna vrijednost pokazatelja utvrđena je u prognozi direktnih pokazatelja efikasnosti, na temelju ostalih indeksa i varijabli. Generalno možemo pretpostaviti da su svi indeksi i ukupni indeks efikasnosti u stonom tenisu statistički značajno povezani s uspjehom igre. Prema tome, indeksi i varijable uspjeha na takmičenju mogu se predvidjeti pomoću svih varijabli i indeksa takmičarske efikasnosti.

METODE

Uzorak entiteta

Konačni uzorak od 956 stonotenisera su igrači koji su se takmičili tokom 2007. godine u raznim rekreativnim stonoteniskim ligama SOKAZ-a, u rasponu od 1. do 20. lige, uz najmanje 33 do najviše

the individuals who played a minimum number of 6 table tennis games. Each individual whose result was collected played at least 6 individual games in the observed period, while the maximum number of games that the individual could play during one competition was 66. All the players were male, aged from 11 to 84.

Variables

The variables in table tennis competition were defined and can be derived directly from the competition results. *Dependent variables*, i.e. predictors (in regression analysis) were direct efficacy indicators:

- *Games won*: total number of games won, for an individual.
- *Sets won*: total number of sets won, for an individual, from the total number of games played.

Independent variables were predictors derived directly from the results (indirect efficacy indicators):

A. efficacy variables

- *Games lost*: total number of games played in which an individual lost the game.
- *Sets lost*: total number of sets played in which an individual lost the set.
- *Sets won with point difference*: total numbers of sets won that were played on difference (won 11-9, 12-10 etc.).
- *Sets lost with point difference*: total number of sets won that were played on point difference (lost 9-11, 10-12, etc.).
- *Games won played in five sets*: total number of games won that were played in five sets (result 3-2 for an individual).
- *Games lost played in five sets*: total number of games lost that were played in five sets (result 2-3 for an opponent).
- *Games won after 0-2 in sets for opponent*: number of games won in which an individual won after losing the first two sets (0-2 advantage of the opponent).
- *Games lost after leading 2-0 in sets*: number of games lost in which an individual lost after winning the first two sets (2-0 advantage of the player).

B. log variables

- *Number of games played*: total number of games played by an individual.
- *Number of sets played*: total number of sets played by an individual.
- *Turnover games (lost after leading 2-0 and won after 0-2)*: total number of games won in which an individual won after losing the first two sets

63 igrača u svakoj ligi. U konačni uzorak odabrali smo pojedince koji su igrali minimalno šest pojedinačnih mečeva u prvenstvu. Maksimalni broj mečeva koje je pojedinac mogao igrati tokom jedne godine bio je 66. Svi igrači bili su muškarci, u dobi od 11 do 84 godine.

Varijable

Definisali smo varijable koje mogu biti izvedene direktno iz rezultata stonoteniskih takmičenja. *Zavisne varijable*, tj. kriteriji (u regresionoj analizi) bili su direktni pokazatelji efikasnosti:

- *Dobijeni mečevi*: ukupan broj dobijenih mečeva za pojedinca.
- *Dobijeni setovi*: ukupan broj dobijenih setova za pojedinca (iz ukupnog broja mečeva).

Nezavisne varijable su prediktori izvedeni direktno iz rezultata (indirektni pokazatelji efikasnosti):

A. varijable efikasnosti

- *Izgubljeni mečevi*: ukupan broj odigranih mečeva u kojima pojedinac gubi meč.
- *Izgubljeni setovi*: ukupan broj odigranih setova u kojem je pojedinac izgubio set.
- *Pobjeda u setovima igranim na razliku poena*: ukupan broj setova u kojima je pojedinac pobijedio, koji su igrani na razliku (pobjeda 11-9, 12-10 itd.).
- *Poraz u setovima igranim na razliku poena*: ukupan broj setova u kojima je pojedinac pobijedio, koji su igrani na razliku (poraz 9-11, 10-12, itd.).
- *Pobjeda u mečevima igranim u pet setova*: ukupan broj pobjeda u mečevima igranim u pet setova (pobjeda 3-2 u korist pojedinca).
- *Poraz u mečevima igranim u pet setova*: ukupan broj poraza u mečevima igranim u pet setova (2-3 pobjeda protivnika).
- *Mečevi dobijeni nakon 0-2 u setovima u korist protivnika*: broj mečeva u kojima je pojedinac pobijedio nakon što je izgubio prva dva seta (0-2 prednost protivnika).
- *Mečevi izgubljeni nakon 2-0 vodstva u setovima*: broj mečeva u kojima je pojedinac izgubio nakon što je dobio prva dva seta (nakon vlastite 2-0 prednosti).

B. zapisničke varijable

- *Broj odigranih mečeva*: ukupan broj odigranih mečeva pojedinca;
- *Broj odigranih setova*: ukupan broj odigranih setova pojedinca;
- *Mečevi s preokretom (porazi nakon vodstva 2-0 i pobjede nakon 0-2)*: ukupan broj mečeva u kojima je pojedinac pobijedio nakon što je izgubio prva

(0-2 advantage of the opponent) and the number of games lost in which an individual lost after winning the first two sets (0-2 advantage of the opponent).
- *Games played in five sets*: total number of games played in five sets (result 3-2 for an individual or 2-3 for the opponent);
- *Sets played on point difference*: total number of sets played on point difference (won 11-9, 12-10 etc. or lost 9-11, 10-12, etc.).

Indexes (indicators of efficiency of an individual) have been defined, which can be derived directly from competition results. These indexes are theoretically considered as a "composite" of two particular variables, while their basic "logic" is a calculation of the ratio between the effectively accomplished number of cases and the maximum possible number of cases, in relation to the hypothetical indicators of efficiency in competitive situations.

As dependent indexes which are direct indicators of players' efficiency i.e. criteria (in regression analysis) have been determined (direct efficacy indicators):

- *Game index*: ratio between the number of games won and lost in all an individual's games: total number of games won is divided by the total number of games played;
- *Set index*: ratio between the number of sets won and lost, in all sets in games played by an individual. Total number of sets won is divided by the total number of sets played.

Independent indexes were predictors derived directly from the results (indirect efficacy indicators):

- *Set played on point difference index*: ratio between the number of sets won and lost in sets played on point difference (11-9, 12-10, 9-11, 10-12 etc.): the number of sets won on point difference is divided by the total number of sets played on point difference.
- *Game played in five sets index*: ratio between the number of won and lost games played in 5 sets (win 3-2 and loss 2-3); the number of games won in 5 sets is divided by the total number of games played in 5 sets.
- *Turnover index*: ratio between the number of games won and lost, in which an individual won after losing the first two sets (0-2 advantage of the opponent), and in games when an individual had an advantage to the opponent leading 2-0 (and finally lost the game).

Finally, the *total efficacy index* is the sum of these three indexes (set played on point difference, game played in five sets, turnover index), as a hypothetical measure of a player's total efficacy, and it is used as a criterion for three predictors (statistical variables):

dva seta (0-2 prednost protivnika) i broj mečeva u kojima je pojedinac izgubio nakon pobjede u prva dva seta (2-0 prednosti).
- *Mečevi igrani u pet setova*: ukupan broj odigranih mečeva u pet setova (3-2 rezultat za pojedinca ili 2-3 za protivnika).
- *Setovi igrani na razliku u poenima*: ukupan broj odigranih setova na razliku (pobjede 11-9, 12-10, itd. ili porazi 9-11, 10-12, itd.).

Odredili smo i *indekse* (pokazatelje efikasnosti pojedinca) koji mogu biti izvedeni direktno iz rezultata takmičenja. Ovi indeksi teoretski su osmišljeni kao "kombinacije" dvaju pojedinačnih varijabli, a njihova osnovna "logika" je proračun omjera između uspješno ostvarenog i maksimalno mogućeg broja slučajeva, u odnosu na hipotetske pokazatelje efikasnosti u takmičarskim situacijama.

Kao zavisni indeksi, utvrđeni su direktni pokazatelji efikasnosti igrača (direktni pokazatelji uspješnosti), tj. kriteriji (u regresionoj analizi):

- *Indeks mečeva*: omjer između broja dobijenih i izgubljenih mečeva u svim odigranim mečevima pojedinca: ukupan broj dobijenih mečeva se dijeli ukupnim brojem odigranih mečeva;
- *Indeks setova*: omjer između broja dobijenih i izgubljenih setova u svim odigranim mečevima pojedinca. Ukupan broj dobijenih setova se dijeli ukupnim brojem odigranih setova.

Nezavisni indeksi su prediktori izvedeni direktno iz rezultata (neizravni pokazatelji efikasnosti):

- *Indeks setova igranih na razliku poena*: omjer između broja setova koje je pojedinac pobijedio i izgubio, u setovima koje se igrao na razliku (11-9, 12-10, 9-11, 10-12, itd.): broj setova u kojima je pojedinac pobijedio na razliku poena dijeli se ukupnim brojem setova igranim na razliku poena;
- *Indeks mečevi u pet setova*: omjer između broja dobijenih i izgubljenih mečeva u 5 setova (pobjede 3-2 i porazi 2-3); broj dobijenih mečeva u 5 setova dijeli se ukupnim brojem odigranih mečeva u 5 setova;
- *Indeks preokreta*: omjer između broja pobjeda i poraza u mečevima u kojima je pojedinac pobijedio nakon što je izgubio prva dva seta (0-2 prednost protivnika), te u mečevima kada je pojedinac preokrenuo prednost protivnika koji je vodio 2-0 (i na kraju izgubio meč).

Konačno, *indeks ukupne efikasnosti* je zbir tih triju indeksa (indeks setova igranih na razliku poena, indeks mečevi u pet setova, indeksa preokreta), kao hipotetska mjera ukupne efikasnosti igrača, te se koristi kao kriterij za tri prediktora (statističke varijable): mečevi s

turnover games, games played in five sets, sets played on point difference.

Procedure

Data collection was performed by inspecting all the results of individuals (players-examinees) from the official web page of the Table Tennis Organization of Clubs and Activities of Zagreb (SOKAZ - www.sokaz.hr). The total result for an individual in a larger number of individual table tennis games and sets was determined. All results were collected from two championships in a period during 2007 (spring and autumn seasons - championships), from different competition ranks in which the given team competed. The role of judges and audience was reduced to a minimum, while games were played for three sets won. As a rule, there are 12 teams in each SOKAZ league (league level), which played games in two-round championship system (each against each), one game at home, and the other as a guest (5 or 6 games as a guest/at home, per championship). On the level of the one team game, each individual plays 3 games against 3 opponents from the other team. So, at the level of the championship, the maximum number of games per one player would be 33.

Statistical Analysis

All data analysis was performed using the SPSS 15.0 package. Descriptive statistics for all variables and indexes were calculated. Pearson correlations were calculated for determining the correlation between all the variables and indexes. Complete multiple regression analysis was used for calculating the prediction of the criteria variables: game index, set index, total efficacy index, games won and sets won.

RESULTS

Table 1 gives descriptive values for all variables and the efficiency indexes for table tennis players in championships in SOKAZ in 2007.

It turned out that most of the distributions of results for the variables and indexes are asymmetric (Table 1). The exceptions are the variables such as *game index, set index* (deviation with $p > .10$) and *total efficacy index* (deviation with $p > .20$), where distributions do not differ significantly from the Gauss distribution. Due to the different range of variables that are direct and indirect indicators of success (conditional frequency of occurrence of certain events such as the number of sets played on point difference), their direct comparison does not give us any information. However, for all indexes that have a total range from 0 to 1, it was obtained the highest average score in the *set index* (among the direct indicators

preokretom, mečevi igrani u pet setova, mečevi igrani na razliku poena.

Procedura

Prikupljanje podataka je provedeno uvidom svih rezultata pojedinaca (stonotenisera) sa službenih veb stranica Stolnoteniske organizacije klubova i aktiva Zagreba (SOKAZ - www.sokaz.hr). Prikupili smo podatke o ukupnim rezultatima pojedinca u većem broju pojedinačnih stonoteniskih mečeva. Svi rezultati su prikupljeni iz dva prvenstva u razdoblju tokom 2007. (proljetne i jesenje sezone prvenstva), iz raznih rangova takmičenja u kojima su se ekipe takmičile. Uloga sudija i publike je bila svedena na minimum, a mečevi su igrani na tri dobijena seta. Po pravilu, postoji po 12 timova u svakoj ligi SOKAZ-a (ranga takmičenja), koji igraju po dvokružnom sistemu takmičenja (svaki protiv svakog), jedno kolo kod kuće, a drugo kao gost (5 do 6 igara kao gost / kod kuće, po prvenstvu). Na nivou timske utakmice, svaki pojedinac igra 3 meča protiv 3 protivnika iz druge ekipe. Dakle, na nivou prvenstva, maksimalan broj pojedinačnih mečeva po stonoteniseru je 33.

Statistička analiza

Sve su analize podataka provedene korištenjem paketa SPSS 15.0. Deskriptivna statistika je izračunata za sve varijable i indekse. Pearsonove korelacije su izračunate za utvrđivanje povezanosti između svih indeksa i varijabli. Kompletnu multiplu regresijsku analizu koristili smo u izračunavanju prognoze kriterijskih varijabli: indeks mečeva, indeks setova, indeks ukupne efikasnosti, dobijenih mečeva, te dobijenih setova.

REZULTATI

U Tabeli 1 date su deskriptivne vrijednosti za sve varijable i indekse efikasnosti za stonotenisere u prvenstvu u SOKAZ-u 2007.

Pokazalo se da je većina distribucija rezultata za varijable i indekse asimetrična (Tabela 1). Izuzetak su *varijable indeks mečeva*, *indeks setova* (odstupanje $p > 0{,}10$) te *indeks ukupne efikasnosti* (odstupanje $p > 0{,}20$), gdje distribucije značajno ne odstupaju od Gaussove krive. Zbog različitih raspona varijabli koje su direktni i indirektni pokazatelji uspjeha (uslovljenih učestalom pojavom pojedinih događaja kao što je npr. broj setova igranih na razliku), njihovo direktno uspoređivanje ne daje nam nikakve informacije. Međutim, za indekse koji svi imaju totalni raspon od 0 do 1, utvrđeno je da je najveći prosječni rezultat pronađen kod *indeksa setova* (među direktnim pokazateljima uspjeha), te

TABLE 1

Descriptive statistics for all the variables and indexes of efficiency for players in the SOKAZ table tennis championships in 2007.

TABELA 1

Deskriptivna statistika za sve varijable i indekse efikasnosti za stonotenisere u stonoteniskom prvenstvu u SOKAZ-u 2007.

Variables	MIN	MAX	Range	*M*	*SD*	K-S test	*p*
1.	1.00	20.00	19	10.9377	5.8612	2.632	.01
2.	1.00	64.00	63	25.1126	12.9873	2.087	.01
3.	.00	64.00	64	12.6639	7.5009	1.963	.01
4.	.00	35.00	35	12.5469	6.8782	2.002	.01
5.	1.00	27.00	26	10.6708	5.7776	1.837	.01
6.	.00	19.00	19	5.3286	3.5917	2.839	.01
7.	.00	20.00	20	5.3270	3.3065	2.751	.01
8.	1.00	8.00	7	2.2942	1.1544	7.348	.01
9.	.00	7.00	7	1.1475	.9026	8.257	.01
10.	.00	6.00	6	1.1467	.8747	8.829	.01
11.	6.00	66.00	93	48.7866	19.6854	3.022	.01
12.	.00	66.00	91	25.337	16.3488	4.354	.01
13.	.00	62.00	62	23.4529	12.4673	2.057	.01
14.	14.00	370.00	356	181.9425	75.6960	3.758	.01
15.	.00	283.00	283	93.7762	52.2356	1.842	.01
16.	.00	186.00	186	88.2239	40.4654	1.625	.01
17.	.00	1.00	1.00	**.4900**	.1764	**1.056**	**.10**
18.	.00	1.00	1.00	.4868	.2347	**1.264**	**.10**
19.	.00	1.00	1.00	.4867	.1575	5.900	.01
20.	.00	1.00	1.00	.4836	.2232	2.432	.01
21.	.00	1.00	1.00	**.4919**	**.3349**	6.310	.01
22.	.00	3.00	3.00	1.4623	.5136	**1.025**	**.20**

Legend: **1.** - League level (Nivo ligaškog takmičenja); **2.** - Sets played on point difference (Setovi igrani na razliku); **3.** - Sets won with point difference (Pobjede u setovima igranim na razliku); **4.** - Sets lost with point difference (Porazi u setovima igranim na razliku); **5.** - Games played in five sets (Mečevi igrani u pet setova); **6.** - Games won played in five sets (Pobjede u mečevima igranim u pet setova); **7.** - Games lost played in five sets (Porazi u mečevima igranim u pet setova); **8.** - Turnover games: lost after leading 2-0 and won after 0-2 (Mečevi s preokretom: izgubljeni nakon vodstva 2-0 i dobijeni nakon zaostatka 0-2); **9.** - Games won after 0-2 in sets for opponent (Mečevi dobijeni nakon 0-2 u setovima u korist protivnika); **10.** - Games lost after leading 2-0 in sets (Mečevi izgubljeni nakon 2-0 vodstva u setovima); **11.** - Number of games played (Broj odigranih mečeva); **12.** - Games won (Dobijeni mečevi); **13.** - Games lost (Izgubljeni mečevi); **14.** - Number of sets played (Broj odigranih setova); **15.** - Sets won (Dobijeni setovi); **16.** - Sets lost (Izgubljeni setovi); **17.** - Set index (Indeks setova); **18.** - Game index (Indeks mečeva); **19.** - Set play on point difference index (Indeks setova igranih na razliku); **20.** - Game played in five sets index (Indeks mečeva igranih u pet setova); **21.** - Turnover index (Indeks mečeva sa preokretima); **22.** - Total efficacy index (Indeks ukupne efikasnosti); ***M*** - Mean (Srednja vrijednost); **MIN** - Lowest value (Najniža vrijednost); **MAX** - Highest value (Najviša vrijednost); ***SD*** - Standard deviation (Standardna devijacija); **K-S test** - Kolmogorov Smirnov test normality of the distribution (Kolmogorov Smirnov test normalnosti raspodjele); ***p*** - Probability (Vjerovatnoća).

of success) and the *turnover index* (among the indirect indicators of success). On the other hand, the greatest variability was found for the *turnover index*, which is actually derived from the variables describing the rarest events in table tennis matches (turnover matches, matches won after loosing 0-2 in sets in favor of the opponent, lost matches after leading 2-0 in sets).

indeksa mečeva s preokretima (među indirektnim pokazateljima uspjeha). S druge strane, najveći varijabilitet pronađen je za *indeks mečeva s preokretima*, koji je zapravo izveden iz varijabli koje opisuju najrjeđe događaje u stolnoteniskim mečevima (mečevi s preokretima, dobijeni mečevi nakon 0-2 u setovima u korist protivnika, izgubljeni mečevi nakon vodstva 2-0 u setovima).

TABLE 2

Pearson correlations between league rank and all the indexes of efficiency for the players in the SOKAZ table tennis championships in 2007.

TABELA 2

Pearsonove korelacije između nivoa ligaškog takmičenja i svih indeksa efikasnosti stonotenisera u stonoteniskim prvenstvima SOKAZ-a u 2007.

Variable	1.	2.	3.	4.	5.	6.	7.
1.	1.000	-.092*	-.096*	-.087*	-.035	-.001	-.054
2.		1.000	.981**	.531**	.232**	.224**	.468**
3.			1.000	.457**	.235**	.183**	.415**
4.				1.000	.149**	.327**	.678**
5.					1.000	.013	.576**
6.						1.000	.729**
7.							1.000

Legend: **1.** - League level (Nivo ligaškog takmičenja); **2.** - Game index (Indeks mečeva); **3.** - Set index (Indeks setova); **4.** - Game played in five sets index (Indeks mečeva igranih u pet setova); **5.** - Set play on point difference index (Indeks setova igranih na razliku); **6.** - Turnover index (Indeks mečeva sa preokretima); **7.** - Total efficacy index (Indeks ukupne efikasnosti); ***** - correlation is significant at the $p < .05$ (korelacija je statistički značajna uz $p < 0{,}05$); ****** - correlation is significant at the $p < .01$ (korelacija je statistički značajna uz $p < 0{,}01$).

Table 2 shows that practically all correlations, apart from four are statistically significant (*league level* with: *turnover index*, *set play on point difference index* and *total efficacy index*; *set play on point difference index* with *turnover index*), and ranged from low (-.087 between league level and game play in five sets index) to very high (.729 between total efficacy index and turnover index). Along with game index (as potentially the most relevant index), the highest (positive and significant) values of correlation (together with the spurious correlation with *set index*) can be found for the following indexes: *total efficacy index*, then *game played in five sets index*, while the lowest correlation value was found for the *set play on point difference index* and *turnover index*, which is normally the least correlated with the remaining efficacy indexes. In lower competitive leagues, players on average have somewhat inferior direct and indirect indicators of table tennis efficacy. Statistically, the *total efficacy index* is significantly correlated (from average to high) with all efficacy indexes of a table tennis player.

U Tabeli 2 je uočljivo da su praktično sve korelacije osim četiri statistički značajne (*nivo ligaškog takmičenja* sa: *indeksom preokreta*, *indeksom setovi igrani na razliku* te *indeksom ukupne efikasnosti*; *indeks preokreta* sa *indeksom setovi igrani na razliku*), i kreću se od niskih (-0,087 između nivoa ligaškog takmičenja i indeks preokreta) do vrlo visokih (0,729 između indeksa ukupne efikasnosti i indeksa preokreta). Sa indeksom mečeva (kao potencijalno najrelevantnijim indeksom) najveće (pozitivne i značajne) vrijednosti korelacija (uz spurioznu korelaciju sa *indeksom setova*) imaju *indeks ukupne efikasnosti*, potom *indeks mečevi igrani u pet setova*, zatim *indeks setova igranih na razliku*, dok je najmanja vrijednost korelacije pronađena za *indeks preokreta*, koji je inače najslabije povezan sa preostalim indeksima efikasnosti. U takmičarski lošijim ligama, igrači u prosjeku imaju nešto lošije direktne i indirektne pokazatelje stonoteniske uspješnosti. *Indeks ukupne efikasnosti* je statistički značajno (osrednje do visoko) povezan sa svim indeksima efikasnosti stonotenisera.

TABLE 3
Prediction of the game index with the other game efficiency indexes for the players in two SOKAZ table tennis championships in 2007.

TABELA 3
Prognoza indeksa mečeva pomoću drugih indeksa efikasnosti meča za stonotenisere u dva stonoteniska prvenstva SOKAZ-a u 2007.

Regression	*R*	R^2	R_c^2	*F*	*p*
	.670	**.448**	**.307**	**257.82**	**.01**
Variables	B	*SE*	ß	*t*	*p*
Game index (D)	-.036	.021		-1.761	.05
Set play on difference index (P)	.588	.037	.394	15.866	**.01**
Game played in five sets index (P)	.458	.028	.436	16.405	**.01**
Turnover index (P)	.032	.018	.045	1.738	.05

Legend: ***R*** - Multiple correlation coefficient (Koeficijent multiple korelacije); ***R²*** - Determination coefficient (Koeficijent determinacije); $\boldsymbol{R_c^2}$ - Corrected determination coefficient (Korigovani koeficijent determinacije); ***F*** - *F*-ratio (*F*-test); ***p*** - Probability (Vjerovatnoća); **B** - Beta coefficient (Beta koeficijent); ***SE*** - Standarda error of estimate (Standardna greška); **ß** - Beta standardize partial contribution (Beta standardizovani parcijalni doprinos) ; ***t*** - *t*-test (*t*-test); **D** - Dependent (Kriterij); **P** - Predictor (Prediktor); Game index - Indeks mečeva; Set Play on difference index - Indeks setova igranih na razliku; Game played in five set index - Indeks mečeva igranih u pet setova; Turnover index - Indeks mečeva sa preokretima.

TABLE 4
Prediction of the set index with the other game efficiency indexes for the players in two SOKAZ table tennis championships in 2007.

TABELA 4
Prognoza indeksa setova pomoću drugih indeksa efikasnosti meča za stonotenisere u dva stonoteniska prvenstva SOKAZ-a u 2007.

Regression	*R*	R^2	R_c^2	*F*	*p*
	.627	**.393**	**.391**	**205.06**	**.01**
Variables	B	*SE*	ß	*t*	*p*
Set index (D)	.114	.016		6.986	**.01**
Set play on difference index (P)	.480	.029	.429	16.430	**.01**
Game played in five sets index (P)	.278	.022	.352	12.627	**.01**
Turnover index (P)	.017	.014	.032	1.172	.20

Legend: ***R*** - Multiple correlation coefficient (Koeficijent multiple korelacije); ***R²*** - Determination coefficient (Koeficijent determinacije); $\boldsymbol{R_c^2}$ - Corrected determination coefficient (Korigovani koeficijent determinacije); ***F*** - *F*-ratio (*F*-test); ***p*** - Probability (Vjerovatnoća); **B** - Beta coefficient (Beta koeficijent); ***SE*** - Standarda error of estimate (Standardna greška); **ß** - Beta standardize partial contribution (Beta standardizovani parcijalni doprinos) ; ***t*** - *t*-test (*t*-test); **D** - Dependent (Kriterij); **P** - Predictor (Prediktor); Set index - Indeks setova; Set Play on difference index - Indeks setova igranih na razliku; Game played in five set index - Indeks mečeva igranih u pet setova; Turnover index - Indeks mečeva sa preokretima.

We have calculated the correlations between the league rank and all the *variables* of efficiency for the players in the SOKAZ table tennis championships in 2007 (we didn't show this correlation matrix because of its prolixity). It appears that practically all correlations are statistically significant and range from low (r = .077; p < .05 between *games lost* and *sets won*) to very high (r = .806; p < .01; between sets played on point difference and games played in five sets), provided we exclude spurious correlations of variables, which are already invariably correlated to a certain extent. Along with the *games won* variable the highest (positive and significant) correlation values can be found for the following variables: *sets won with difference*, *games won played in five sets*, but also *sets played*, *games played*, *sets played with difference*, and *games played in five sets*. It is interesting that in this case the lowest (although significant and positive correlations) with the *games won* variable were found for *turnover games*, as well as for the variables *games won after 0-2 in sets for opponent* and *games lost after leading 2-0 in sets*. In lower competitive leagues, players on average have less frequent occurrences of efficacy indicators of table tennis players (direct and indirect), as well as log variables, which shows a negative indication of all (although low, but statistically significant) correlations between the league level and other variables. Statistically, the *total efficacy index* is significantly averagely correlated with all major variables, which constitute the efficacy indicators of table tennis players: *games won*, *games won after 0-2 in sets for opponent*, *sets won with difference*, and *games won played in five sets*.

Table 3 shows that the game index, as the ratio of victories in table tennis games in relation to the total number of games, can be statistically predicted in a significant and successful manner, based on a group of three predictors, i.e. the remaining efficacy indexes: the set played on point difference index and the game played in five sets index (statistically significant predictors, with p < .01).

From Table 4 one can see that the *set index*, as the ratio of sets won in table tennis games in relation to the total number of sets played, can also be statistically predicted in a significant and successful manner, based on a group of three predictors the remaining efficacy indexes: the *set played on point difference index* and *the game played in five sets index* (statistically significant predictors, with p < .01).

In both cases (Table 3 and 4), the *turnover index* was the statistically insignificant predictor.

It is clear (Table 5) that the *games won variable*, as the simplest but also the most relevant efficacy index in table tennis games, can be statistically predicted in a significant and successful manner, based on a group

Izračunali smo i korelacije između nivoa ligaškog takmičenja i svih *varijabli* efikasnosti stonotenisera u stonoteniskim prvenstvima SOKAZ-a (ovu korelacijsku matricu zbog opširnosti nismo prikazali). Sve korelacije pokazale su se statistički značajne, i kreću se od niskih (r = 0,077; p < 0,05; između *izgubljenih mečeva* i *dobijenih setova*) do vrlo visokih (r = 0,806; p < 0,01; između *mečeva igranih u pet setova* i *setova igranih na razliku u poenima*), ukoliko ne razmatramo spuriozne korelacije varijabli koje su već u startu nužno povezane u određenoj mjeri (npr. broj dobijenih mečeva i dobivenih setova). S varijablom dobijeni mečevi najveće (pozitivne i značajne) vrijednosti korelacija imaju varijable: *setovi dobijeni na razliku*, *dobijeni mečevi igrani u pet setova*, ali i *odigrani setovi*, *odigrani mečevi*, i *setovi igrani na razliku*, te *mečevi igrani u pet setova*. Zanimljivo je da su i u ovom slučaju najniže (premda statistički značajne i pozitivne korelacije) s varijablom *dobijeni mečevi* pronađene za varijable *mečevi sa preokretom*, te za *dobijeni mečevi nakon 0-2 u setovimaza protivnika* i *izgubljeni mečevi nakon vodstva 2-0 u setovima*. U takmičarski lošijim ligama, igrači u prosjeku imaju rjeđu zastupljenost pokazatelja efikasnosti stonotenisera (direktnih i indirektnih), ali i zapisničkih varijabli, što pokazuje negativni predznak svih (premda niskih ali statistički značajnih) korelacija između nivoa ligaškog takmičenja i ostalih varijabli. Ukupni indeks efikasnosti je statistički značajno osrednje povezan sa svim glavnim varijablama koje su indikatori efikasnosti stonoteniskog takmičara: *dobijeni mečevi*, *dobijeni mečevi nakon 0-2 u setovima za protivnika*, *setovi dobijeni na razliku* i *dobijeni mečevi igrani u pet setova*.

U Tabeli 3 je uočljivo da se indeks mečeva (omjer pobjeda u stonoteniskim mečevima u odnosu na ukupni broj mečeva) može statistički značajno uspješno prognozirati na osnovu grupe od tri prediktora, tj. preostalih indeksa efikasnosti: indeks setova dobijenih na razliku i indeks mečevi u pet setova (statistički značajni prediktori, uz p < 0,01).

U Tabeli 4 je uočljivo da se *indeks setova* (omjer dobijenih setova u stonoteniskim mečevima u odnosu na ukupni broj odigranih setova) također može statistički značajno uspješno prognozirati na osnovu grupe od tri prediktora, tj. preostalih indeksa efikasnosti: *indeks setovi igrani na razliku* i *indeks mečevi u pet setova* (statistički značajni prediktori, uz p < 0,01).

U oba slučaja (Tabele 3 i 4), *indeks preokreta* nije se pokazao statistički značajnim prediktorom.

U Tabeli 5 je uočljivo da se varijabla *dobijeni mečevi*, kao najjednostavniji ali i najrelevantniji indikator uspjeha u stonoteniskim susretima, može statistički značajno uspješno prognozirati na osnovu grupe od

TABLE 5

Prediction of the variable games won with game efficiency variables for the players in two SOKAZ table tennis championships in 2007.

TABELA 5

Prognoza varijable dobijeni mečevi pomoću drugih indeksa efikasnosti meča za stonotenisere u dva stonoteniska prvenstva SOKAZ-a u 2007.

Regression	*R*	R^2	R_c^2	*F*	*p*
	.745	**.556**	**.553**	**197.82**	**.01**
Variables	B	*SE*	ß	*t*	*p*
Games won (D)	6.069	.935		6.488	**.01**
Sets won with point difference (P)	1.209	.069	.555	17.522	**.01**
Sets lost with point difference (P)	-.067	.079	-.028	-.850	.20
Games won played in five sets (P)	1.569	.141	.345	11.117	**.01**
Games lost played in five sets (P)	-.743	.149	-.150	-4.968	**.01**
Games won after 0-2 in sets for opponent (P)	.403	.443	.022	.911	.20
Games lost after leading 2-0 in sets (P)	-.064	.449	-.003	-.142	.20

Legend: ***R*** - Multiple correlation coefficient (Koeficijent multiple korelacije); ***R²*** - Determination coefficient (Koeficijent determinacije); $\boldsymbol{R_c^2}$ - Corrected determination coefficient (Korigovani koeficijent determinacije); ***F*** - *F*-ratio (*F*-test); ***p*** - Probability (Vjerovatnoća); **B** - Beta coefficient (Beta koeficijent); ***SE*** - Standarda error of estimate (Standardna greška); **ß** - Beta standardize partial contribution (Beta standardizovani parcijalni doprinos) ; ***t*** - *t*-test (*t*-test); **D** - Dependent (Kriterij); **P** - Predictor (Prediktor); Games won - Dobijeni mečevi; Sets won with point differenece - Pobjede u setovima igranim na razliku; Sets lost with point difference - Porazi u setovima igranim na razliku; Games won played in five sets - Pobjede u mečevima igranim u pet setova; Games lost played in five sets - Porazi u mečevima igranim u pet setova; Games won after 0-2 in sets for opponent - Mečevi dobijeni nakon 0-2 u setovima u korist protivnika; Games lost after leading 2-0 in sets - Mečevi izgubljeni nakon 2-0 vodstva u setovima.

of three predictors, i.e. the remaining variables of a table tennis player's efficacy: *sets won with point difference*, *games won played in five sets*, and *games lost played in five sets* (all predictors are statistically significant with $p < .01$).

Observing Table 6, one can see that *sets won*, as a similar efficacy index in table tennis games, can be statistically predicted in a significant and successful manner, based on a group of six predictors, i.e. the remaining variables of a table tennis player's efficacy: *sets won with point difference* and *games won played in five sets* (all predictors are statistically significant with $p < .01$).

In both cases (Table 5 and 6), *turnover variables* were statistically insignificant predictors.

Table 7 shows that the *game index* can be statistically predicted in a significant and successful manner, based on a group of three predictors, i.e. neutral or log variables: *sets played on point difference* and *sets played in five sets* (statistically significant predictors, with $p < .01$).

šest prediktora, tj. preostalih varijabli-pokazatelja stonoteniserove efikasnosti, od kojih su tri bila statistički značajna: *setovi dobijeni na razliku*, *mečevi dobijeni u pet setova*, i *mečevi izgubljeni u pet setova* (svi uz $p < 0{,}01$).

U Tabeli 6 je uočljivo da se varijabla *dobijeni setovi*, kao drugi indikator uspjeha u stonoteniskim susretima, može statistički značajno uspješno prognozirati na osnovu grupe od šest prediktora, tj. preostalih varijabli-pokazatelja stonoteniserove efikasnosti, od kojih su dva bila statistički značajna: *setovi dobijeni na razliku*, te *mečevi dobijeni u pet setova* (oba uz $p < 0{,}01$).

U oba slučaja (Tabele 5 i 6), varijable rezultatskog preokreta bile su statistički neznačajni prediktori.

U Tabeli 7 je uočljivo da se *indeks mečeva* može statistički značajno uspješno prognozirati na osnovu grupe od tri prediktora, tj. zapisničkih varijabli, od kojih su dve bile statistički značajne: *setovi igrani na razliku poena*, te *mečevi u pet setova* (uz $p < 0{,}01$).

TABLE 6

Prediction of the variable sets won with the other game efficiency variables for the players in two SOKAZ table tennis championships in 2007.

TABELa 6

Prognoza varijable dobijeni setovi pomoću drugih indeksa efikasnosti meča za stonotenisere u dva stonoteniska prvenstva SOKAZ-a u 2007.

Regression	*R*	R^2	R_c^2	*F*	*p*
	.786	**.618**	**.616**	**256.29**	**.01**
Variables	B	*SE*	ß	*t*	*p*
Sets won (D)	19.531	2.770		7.052	**.01**
Sets won with point difference (P)	3.725	.204	.535	18.228	**.01**
Sets lost with point difference (P)	.404	.234	.053	1.728	.05
Games won played in five sets (P)	4.227	.418	.291	10.114	**.01**
Games lost played in five sets (P)	-.245	.443	-.015	-.553	.20
Games won after 0-2 in sets for opponent (P)	1.056	1.311	.018	.805	.20
Games lost after leading 2-0 in sets (P)	-.372	1.331	-.006	-.279	.20

Legend: ***R*** - Multiple correlation coefficient (Koeficijent multiple korelacije); ***R²*** - Determinantion coefficient (Koeficijent determinacije); $\boldsymbol{R_c^2}$ - Corrected determination coefficient (Korigovani koeficijent determinacije); ***F*** - *F*-ratio (*F*-test); ***p*** - Probability (Vjerovatnoća); **B** - Beta coefficient (Beta koeficijent); ***SE*** - Standarda error of estimate (Standardna greška); **ß** - Beta standardize partial contribution (Beta standardizovani parcijalni doprinos) ; ***t*** - *t*-test (*t*-test); **D** - Dependent (Kriterij); **P** - Predictor (Prediktor); Sets won - Dobijeni setovi; Sets won with point differenece - Pobjede u setovima igranim na razliku; Sets lost with point difference - Porazi u setovima igranim na razliku; Games won played in five sets - Pobjede u mečevima igranim u pet setova; Games lost played in five sets - Porazi u mečevima igranim u pet setova; Games won after 0-2 in sets for opponent - Mečevi dobijeni nakon 0-2 u setovima u korist protivnika; Games lost after leading 2-0 in sets - Mečevi izgubljeni nakon 2-0 vodstva u setovima.

TABLE 7

Prediction of the variable game index with log variables for the players in two SOKAZ table tennis championships in 2007.

TABLE 7

Prognoza varijable indeks mečeva pomoću zapisničkih varijabli za stonotenisere u dva stonoteniska prvenstva SOKAZ-a u 2007.

Regression	*R*	R^2	R_c^2	*F*	*p*
	.670	**.448**	**.447**	**252.82**	**.01**
Variables	B	*SE*	ß	*t*	*p*
Game index (D)	-.036	.021		-1.761	.05
Turnover games (lost after leading 2-0 and won after 0-2) (P)	.031	.018	.045	1.738	.05
Games played in five sets (P)	.458	.028	.436	16.405	**.01**
Sets played on point difference (P)	.558	.037	.394	15.866	**.01**

Legend: ***R*** - Multiple correlation coefficient (Koeficijent multiple korelacije); ***R²*** - Determinantion coefficient (Koeficijent determinacije); $\boldsymbol{R_c^2}$ - Corrected determination coefficient (Korigovani koeficijent determinacije); ***F*** - *F*-ratio (*F*-test); ***p*** - Probability (Vjerovatnoća); **B** - Beta coefficient (Beta koeficijent); ***SE*** - Standarda error of estimate (Standardna greška); **ß** - Beta standardize partial contribution (Beta standardizovani parcijalni doprinos) ; ***t*** - *t*-test (*t*-test); **D** - Dependent (Kriterij); **P** - Predictor (Prediktor); Game index - Indeks mečeva; Turnover games: lost after leading 2-0 and won after 0-2 - Mečevi s preokretom: izgubljeni nakon vodstva 2-0 i dobiveni nakon zaostatka 0-2; Games played in five sets - Mečevi igrani u pet setova; Sets played on point difference - Setovi igrani na razliku.

TABLE 8
Prediction of the variable games won with log variables for the players in SOKAZ table tennis championships in 2007.

TABELA 8
Prognoza varijable dobijeni mečevi pomoću zapisničkih varijabli za stonotenisere u dva stonoteniska prvenstva SOKAZ-a u 2007.

Regression	*R*	R^2	R_c^2	*F*	*p*
	.595	**.357**	**.354**	**129.82**	**.01**
Variables	B	*SE*	ß	*t*	*p*
Game wons (D)	6.040	1.289		4.685	**.01**
Turnover games (lost after leading 2-0 and won after 0-2) (P)	-.064	.399	-.006	-.160	.20
Games played in five sets (P)	.220	.141	.080	1.555	.10
Sets played on point difference (P)	.703	.063	.536	11.103	**.01**

Legend: ***R*** - Multiple correlation coefficient (Koeficijent multiple korelacije); ***R²*** - Determination coefficient (Koeficijent determinacije); R_c^2 - Corrected determination coefficient (Korigovani koeficijent determinacije); ***F*** - *F*-ratio (*F*-test); ***p*** - Probability (Vjerovatnoća); **B** - Beta coefficient (Beta koeficijent); ***SE*** - Standarda error of estimate (Standardna greška); **ß** - Beta standardize partial contribution (Beta standardizovani parcijalni doprinos) ; ***t*** - *t*-test (*t*-test); **D** - Dependent (Kriterij); **P** - Predictor (Prediktor); Game wons - Dobijeni mečevi; Turnover games: lost after leading 2-0 and won after 0-2 - Mečevi s preokretom: izgubljeni nakon vodstva 2-0 i dobiveni nakon zaostatka 0-2; Games played in five sets - Mečevi igrani u pet setova; Sets played on point difference - Setovi igrani na razliku.

TABLE 9
Prediction of the index total efficacy with log variables for the players in SOKAZ table tennis championships in 2007.

TABELA 9
Prognoza varijable indeks ukupne efikasnosti pomoću zapisničkih varijabli za stonotenisere u dva stoloteniska prvenstva SOKAZ-a u 2007.

Regression	*R*	R^2	R_c^2	*F*	*p*
	.156	**.024**	**.020**	**5.84**	**.01**
Variables	B	*SE*	ß	*t*	*p*
Total efficacy (D)	1.290	.057		22.517	**.01**
Turnover games (lost after leading 2-0 and won after 0-2) (P)	-.018	.018	-.044	-1.026	.20
Games played in five sets (P)	.069	.006	.070	1.104	.20
Sets played on point difference (P)	.053	.003	.111	1.868	.05

Legend: ***R*** - Multiple correlation coefficient (Koeficijent multiple korelacije); ***R²*** - Determination coefficient (Koeficijent determinacije); R_c^2 - Corrected determination coefficient (Korigovani koeficijent determinacije); ***F*** - *F*-ratio (*F*-test); ***p*** - Probability (Vjerovatnoća); **B** - Beta coefficient (Beta koeficijent); ***SE*** - Standarda error of estimate (Standardna greška); **ß** - Beta standardize partial contribution (Beta standardizovani parcijalni doprinos) ; ***t*** - *t*-test (*t*-test); **D** - Dependent (Kriterij); **P** - Predictor (Prediktor); Total efficacy - Ukupna efikasnost; Turnover games: lost after leading 2-0 and won after 0-2 - Mečevi s preokretom: izgubljeni nakon vodstva 2-0 i dobiveni nakon zaostatka 0-2; Games played in five sets - Mečevi igrani u pet setova; Sets played on point difference - Setovi igrani na razliku.

From Table 8, it can be deduced that the *games won* variable can be statistically predicted in a significant and successful manner, based on a group of three predictors, i.e. neutral or log variables, among which one is statistically significant predictor: s*ets played on point difference* (with $p < .01$).

Finally, in Table 9 it is evident that the *total efficacy* variable, as a indicator of total result efficacy, can be statistically predicted in a significant and successful manner, based on a group of three predictors, i.e. neutral or log variables, among which all predictors are statistically insignificant.

DISCUSSION

The main research findings reached the conclusion that, even with a small number of indexes and variables derived directly from the results of table tennis games, a statistically significant correlation with the final result in table tennis games (*winning a game or set*), can be found. Moreover, compared with previous research provided by Sindik and Kondrič (2011), the results are (with minor exceptions) almost identical to the results conducted one year ago on an almost identical sample. On the one hand, these results confirm the results of the previous research, thus indicating the "stability" of the predictive characteristics of the index and variables deduced directly from the results of table tennis games in the league championships and for the so-called direct efficacy indicators. On the other hand, the results are probably also stable characteristics of the score achievement of table tennis players in a large-scale table tennis competition, such as the one in SOKAZ (Association of Recreational Table Tennis Players of Zagreb), as same for the elite table tennis competitions.

With regards to the inter-correlation of efficiency indexes and variables on the basis of competition results (Table 2), many statistically significant correlations of »direct« indicators of efficiency are noticeable. Thus, direct indicators of efficiency (*game index*, *set index*, *games won*, *games lost*, *sets won*, and *sets lost*) are medium or strongly and significantly correlated with other indexes and variables. It is interesting that the variables indicating the number of defeats (in sets or matches) are also statistically correlated significantly and positively (although with somewhat lower values) with direct efficacy indexes. However, it was evident that the *turnover index* is the least correlated with direct efficacy indicators (correlations are statistically significant, but low) of all the indirect indicators of competitive efficacy (*turnover index* and associated variables, sets won with point difference and associated variables, *games won played in five sets index*, and associated variables). Even though the correlation is spurious, it was clear that the *turnover index* is highly and positively

U Tabeli 8 je uočljivo da se varijabla *dobijeni mečevi*, može statistički značajno uspješno prognozirati na osnovu grupe od tri prediktora, tj. zapisničkih varijabli, od kojih je jedan bio statistički značajan: *setovi igrani na razliku poena* (uz $p < 0,01$).

Konačno, u Tabeli 9 je uočljivo da se indeks *ukupna efikasnost*, kao pokazatelj ukupne rezultatske efikasnosti, može statistički značajno uspješno prognozirati na osnovu grupe od tri prediktora, tj. zapisničkih varijabli, od kojih niti jedan nije bio statistički značajan.

DISKUSIJA

Glavni nalaz istraživanja sastoji se u konstataciji da se čak i uz mali broj indeksa i varijabli, koji se mogu direktno izvesti iz rezultata stonoteniskih susreta, može pronaći njihova statistički značajna povezanost s konačnim uspjehom u stonoteniskim mečevima (*pobjeda u meču ili setu*). Štaviše, u poređenju s prethodnim istraživanjem Sindika i Kondriča (2011), rezultati su (uz manje izuzetke) gotovo jednaki rezultatima provedenih godinu dana ranije na gotovo identičnom uzorku. S jedne strane, ovi rezultati potvrđuju rezultate prethodnog istraživanja, što upućuje na "stabilnost" prediktivnih obilježja indeksa i varijabli izvedenih direktno iz rezultata stonoteniskih takmičenja u ligaškim prvenstvima i za takozvane direktne pokazatelje efikasnosti. S druge strane, rezultati vjerovatno pokazuju i stabilnost karakteristika rezultatskih ostvarenja stonotenisera u velikim stonoteniskim takmičenjima, kao što su ova u SOKAZ--u (Udruga stonotenisera rekreativaca Zagreba), kao i elitnih stonoteniskih takmičenja.

S obzirom na međusobne povezanosti efikasnosti indeksa i varijabli na osnovu rezultata takmičenja (Tabela 2), primjetne su mnoge statistički značajne korelacije tzv. direktnih pokazatelja efikasnosti. Naime, pokazalo se da su direktni indikatori efikasnosti (*indeks mečeva*, *indeks setova*, *pobjede* i *porazi u mečevima*, *dobijeni* i *izgubljeni setovi*) srednje visoko i visoko značajno povezani s drugim indeksima i varijablama. Zanimljivo je da su i varijable koje ukazuju na broj poraza (u setovima ili mečevima) statistički značajno i pozitivno (premda nešto nižih vrijednosti) povezane s direktnim pokazateljima uspješnosti. Međutim, pokazalo se da je od indirektnih pokazatelja takmičarske uspješnosti *(indeks preokreta* i pripadajućih varijabli, i*ndeks setova dobijenih na razliku* i pripadajućih varijabli, i*ndeks mečeva dobijenih u pet setova* i pripadajućih varijabli), *indeks preokreta* najslabije povezan s direktnim pokazateljima uspješnosti (korelacije su statistički značajne ali niske).

correlated with the *total efficacy index*, which is information providing a guideline for future research. The *total efficacy index* is statistically and positively correlated with all efficacy indexes, as well as with variables indicating games and sets won: *sets won with point difference*, *games won played in five sets*, and *games won after 0-2 in sets for opponent*. However, correlations of the *total efficacy index* are negative or zero in relation to variables indicating games and sets lost: *sets lost with point difference*, *games lost played in five sets*, and *games lost after leading 2-0 in sets*; therefore also to variables that are indirect efficacy indexes, and especially to the indexes deriving from them. An interesting point is that all direct and indirect efficacy indexes are negatively (although weakly, but significantly) correlated with the league level; therefore, even in the "weaker" competitive leagues these indexes have lower values. This can indirectly imply information about varying levels of uncertainty for competitions in "stronger" or "weaker" leagues (Sindik & Vidak, 2009).

Observing Tables 3 to 6 it is clear that all direct efficacy indicators of table tennis players (variables and indexes) can be successfully predicted based on indirect efficacy indicators. The most successful predictors are *sets won with point difference* (variable) and the *sets won with point difference index*, while the least successful predictors (at the same time also statistically insignificant) are the *turnover index* and *games won after 0-2 in sets for opponent*, or rather *games lost after leading 2-0 in sets*. This information can probably be explained by the fact that big result turnovers are a fairly rare event in table tennis games. On the other hand, sets won with point difference are events occurring somewhat more frequently than games won played in five sets.

For Tables 7 and 8, one can deduce that, among predictors that are neutral or log variables, the *total number of sets played on point difference* is the best predictor of direct indicators of efficiency: *games won and game index*. Therefore, the *total number of sets played on point difference* is the best predictor of result success, which is also reflected in successful prediction of the *total efficacy index* (Table 9). (*For the total efficacy index as a criterion, we did not show predictions based on the indirect efficacy indexes of table tennis players because predictions based on all indirect indexes of a table tennis player's success are spurious, even though they registered as statistically significant. That is to say, the total efficacy index is obtained by a simple linear combination of three indirect efficacy indexes*.)

One relevant fault of all efficiency indicators (indexes and variables) directly derived from competition results is that the total result does not necessarily need to be a real "measure" of player competitive efficiency. In practical situations in competition, players might be 'laid-back' in situations of more significant result advantage or might »hold back« in

Premda je korelacija spuriozna, pokazalo se da je *indeks preokreta* visoko i pozitivno povezan s *indeksom ukupne efikasnosti*, što je podatak koji daje smjernice za buduća istraživanja. *Indeks ukupne efikasnosti* je statistički značajno i pozitivno povezan sa svim ostalim indeksima efikasnosti, kao i s varijablama koje ukazuju na dobijene mečeve i setove: *setove dobijeni na razliku*, *mečevi dobijeni u pet setova*, *mečevi dobijeni nakon gubljenja 0-2 u setovima*. Međutim, korelacije *indeksa ukupne efikasnosti* su negativne ili nulte u odnosu na varijable koje ukazuju na izgubljene mečeve i setove: *setove izgubljene na razliku*, *mečevi izgubljene u pet setova*, i *mečevi izgubljeni nakon vodstva 2-0 u setovima*. Zanimljiv je podatak da su svi indirektni i direktni indeksi efikasnosti negativno (premda nisko ali značajno) povezani s nivoom ligaškog takmičenja, dakle u takmičarski "slabijim" ligama i ovi indeksi su nižih vrijednosti. To indirektno može ukazivati na podatak o različitoj neizvjesnosti takmičenja u "jačim" ili "slabijim" ligama (Sindik i Vidak, 2009).

U Tabelama 3 – 6 je uočljivo da se svi direktni pokazatelji uspješnosti stonotenisera (varijable i indeksi) mogu uspješno prognozirati na osnovu indirektnih pokazatelja uspješnosti. Najuspješniji prediktori su *setovi dobijeni na razliku* (varijabla), te *indeks setova dobijenih na razliku*, a najneuspješniji (ujedno i statistički neznačajni) su *indeks preokreta* te *mečevi dobiijeni nakon gubljenja 0-2*, odnosno *izgubljene nakon vodstva 2-0*. Ovaj podatak vjerovatno je uzrokovan činjenicom da su veliki rezultatski preokreti relativno rijedak događaj na stonoteniskim susretima. S druge strane, setovi dobijeni na razliku su relativno češći događaj nego susreti dobijeni u pet setova.

U Tabelama 7 i 8 uočljivo je da je među prediktorima koji su zapravo zapisničke varijable, također *ukupni broj setova igranih na razliku* najbolji prediktor direktnih pokazatelja uspjeha: *dobijenih mečeva* i *indeksa mečeva*. Dakle, *ukupan broj setova igranih na razliku* najbolji je prediktor rezultatskog uspjeha, što se odrazilo i na uspješnu predikciju indeksa *ukupne efikasnosti* (Tabela 9). (*Za indeks ukupne efikasnosti kao kriterij nisu prikazane prognoze na temelju indirektnih pokazatelja uspješnosti stonotenisera iz razloga što su predikcije na osnovu svih indirektnih pokazatelja uspjeha stonotenisera spuriozne, premda su se pokazale statistički značajne. Naime, indeks ukupne efikasnosti je dobijen jednostavnom linearnom kombinacijom tri indirektna indeksa uspješnosti*).

Bitan nedostatak svih pokazatelja efikasnosti (indeksa i varijabli) koji direktno proizlaze iz takmičarskih rezultata jeste činjenica da ukupan rezultat ne mora nužno biti prava mjera stonoteniserove takmičarske efikasnosti. U praktičnim situacijama takmičenja, može doći do opuštanja stonotenisera u situacijama

relation to an opponent, or there could be »predictions« of convincing victory or defeat, which result in »playing«with anticipated inferior or »superior« opponents during the entire event (Sindik & Juričević, 2007). We should not forget that we are not talking about top-quality table tennis, but recreational table tennis (our sample of subjects); therefore we should be additionally careful in generalizing these results. However, on average and in competitions that are more equal in terms of results, the suggested efficiency indicators could be useful.

On the basis of these results, one could cautiously presume that *winning in sets won with point difference* and associated variables and index, as well as *winning in games played in five sets* are "more critical" for the final outcome of the game (games won, sets won, game index, total efficacy index), at least in the case of this sample. It is not only wins in *sets played on point difference*, but also the *number of sets played on point difference* itself (as a log variable), that can predict in a statistically significant manner the direct efficacy indexes of table tennis players, and also the total efficacy index. Thus, we can consider that *sets played on point difference* (just as *games played in five sets*, and, with a lower impact - *turnover games*) could be very important elements in understanding the efficacy of the table tennis player in a sequence of games. On the basis of analysis of such elements, it would be necessary (for a specific sample of table tennis players) to prepare two more basic strategies when planning a training transformation process (possibly "psychologically" decisive for the final outcome of an individual table tennis game).

First, to attempt to steer players towards focusing on the importance of maximum optimal motor performance and psychological engagement in the *decisive part* of an individual table tennis game: with the goal of winning the set played on point difference (at the level of a sequence of a few games, focus is needed on potential games played in five sets and potential turnover games). In other words, an individual has to be focused to win in "sensitive" game situations (set played on point difference), and must avoid "easing off" when leads in points and sets occur (games played in five sets and turnover games). Second, to assure the optimal motor performance and psychological stability of an individual in situations when an unfavourable outcome has already occurred (when a player has lost a game played in five sets or a turnover game, or when a player has lost a set played in point difference).

This study examined different players at varying levels of competitive quality (in relation to the competition effect) and different levels of quality in their opponents, which is a significant improvement in relation to earlier research studies. Moreover, we tested

značajnije rezultatske prednosti ili gubitka u odnosu na protivnika, predviđajući uvjerljivu pobjedu ili poraz, dok igraju s predvidljivo lošijim ili superiornijim protivnikom tokom cijelog prvenstva (Sindik i Juričević, 2007). Ne smijemo zaboraviti ni činjenicu da nije riječ o vrhunskom, već o rekreativnom stonom tenisu, zbog čega dodatno trebamo biti oprezni u generalizaciji ovih rezultata. Međutim, u prosjeku i u rezultatski izjednačenijim takmičenjima, predloženi pokazatelji efikasnosti mogu biti vjerovatno vrlo korisni.

Na osnovu rezultata, možemo oprezno pretpostaviti da su *pobjeda u setovima na razliku* i pripadajućim varijablama i indeksima, kao i *pobjede u mečevima igranim u pet setova* kritični događaji za konačni ishod meča (dobiveni mečevi i setovi, indeks mečeva, indeks ukupne efikasnosti), barem kod ispitanog uzorka entiteta. Ne samo pobjede u *setovima igranim na razliku*, već i sam *broj setova igranih na razliku* (kao zapisnička varijabla), statistički značajno prognozira ne samo direktne pokazatelje uspješnosti stonotenisera, već i indeks ukupne efikasnosti. Naime, možemo uzeti u obzir da setovi igrani na razliku (isto *kao i mečevi igrani u pet setova*, i uz nešto manji uticaj - *preokrenuti mečevi*) mogu biti vrlo važni elementi za razumijevanje efikasnost stolnotenisera u nizu mečeva. Na temelju analize takvih elemenata, bilo bi potrebno (za određeni uzorak stonotenisera) planirati dvije osnovne strategije, u procesu planiranja treninga (možda "psihološki" odlučujuće za konačni ishod pojedinog stolnoteniskog meča).

Prvo, pokušati usmjeriti igrače da se fokusiraju na važnost maksimalne vještine i motoričkog i psihološkog angažovanja u *odlučujućem dijelu* pojedinog stolnoteniskog meča: s ciljem dobijanja seta igranog na razliku poena (na nivou niza od nekoliko mečeva, fokus je potrebno usmjeriti na: potencijalne mečeve igrane u pet setova i potencijalne mečeve s preokretom). Drugim riječima: pojedinac mora biti usmjeren pokušati pobijediti u "osjetljivim" situacijama u meču (setovi igrani na razliku), te kako bi se spriječilo"opuštanje" kod vodstva u poenima i setovima (mečevi u pet setova i mečevi s preokretom). Drugo, težiti osiguranju optimalne vještine, te motoričkoj i psihološkoj stabilnost pojedinca u situacijama kad su nepovoljni ishodi već nastali (kad igrač izgubio meč igran u pet setova i meč s preokretom, ili kada je igrač izgubio set igran na razliku).

U ovom istraživanju ispitali smo igrače različitih nivoa takmičenja (u odnosu na takmičarski učinak), različitih nivoa kvalitete sportskih protivnika, što je bitno poboljšanje u odnosu na ranija istraživanja.

a much larger sample, practically the whole population of table tennis players in the recreational leagues of SOKAZ (who have played a minimum of 8 games per year).

However, it is desirable in any case to inspect the proposed variables and indexes (direct and indirect indicators) of player efficacy in future research, on a sample of elite table tennis players, perhaps not only male, and also from different age groups. We could also use more indirect indicators of player efficacy, as did Sindik and Juričević (2007), on the two sets won and 21 points won point-system.

CONCLUSION

As a conclusion, it was demonstrated that correlations between individual variables of a table tennis competitor's efficiency are statistically significant (1), as well as the correlations between indexes of a table tennis competitor's efficiency are also statistically significant and positive (2). The *total efficiency index* was significantly high and moderately positively associated with all major variables that are indicators ofthe efficiency of table tennis players: *won games, games won after 0-2 in sets for the opponent*, *sets won with the difference*, and *games won played in five sets* (3). In particular, we found positive (and significant) correlations between all the direct and indirect indicators of player efficacy (medium high to high correlated). Finally, indexes and variables directly derived from the results can predict indexes and variables of final competition success to a statistically significant degree: *game index*, *set index*, *games won*, and *sets won*. Log variables can predict the total index of final competitive success to a statistically significant degree: *total efficacy index*.

Također, ispitali smo puno veći uzorak, praktično cijelu populaciju stonotenisera u rekreativnim ligama SOKAZ-a (koji su odigrali minimalno 8 mečeva u godini).

Međutim, poželjno je u svakom slučaju ispitati predložene varijable i indekse (direktnih i indirektnih pokazatelja) stonoteniserove efikasnosti u budućim istraživanjima, na uzorku ispitanika elitnih igrača stonog tenisa, možda ne samo muških, i iz različitih uzrasnih grupa. Također bi mogli koristiti više od indirektnih indikatora igračeve uspješnosti, kao Sindik i Juričević (2007), kod sistema takmičenja igre na dva dobijena seta do 21 dobijenog poena.

ZAKLJUČAK

U odnosu na ciljeve istraživanja, pokazalo se da su sve korelacije između pojedinih varijabli stolnoteniserove takmičarske efikasnosti statistički značajne (1), kao i između indeksa takmičarske efikasnosti u stonom tenisu koje su statistički značajne i pozitivne (2). *Ukupni indeks efikasnosti* je statistički značajno osrednje visoko i pozitivno povezan sa svim glavnim varijablama koje su indikatori efikasnosti stolnoteniskog takmičara: *dobijeni* mečevi, *dobijeni mečevi nakon 0-2 u setovima za protivnika*, *setovi dobijene na razliku* i *dobijeni mečevi igrani u pet setova* (3). Pronašli smo srednje visoke pozitivne i statistički značajne korelacije između svih direktnih i indirektnih pokazatelja stonoteniserove efikasnosti. Indekse i varijable direktno izvedene iz rezultata se može statistički značajno predvidjeti pomoću indeksa i varijabli konačnog uspjeha u takmičenju: *indeksa mečeva*, *indeksa setova*, *pobjeda u mečevima* i *dobijenim setovima*. Zapisničke varijable mogu statistički značajno predvidjeti indeks konačnog uspjeha u takmičenju, tj. *indeks ukupne efikasnosti* (4).

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VERBINDUNG ZWISCHEN DEM INDEX UND DEN VARIABLEN DES ERFOLGS IM REKREATIVEN TISCHTENNISSPIEL

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Unter den verschiedenen Methoden der Qualitätsanalyse eines Tischtennisspielers, war der Grundgedanke dieser Studie, diejenigen Indikatoren (Daten) zu bestimmen, von denen ausreichend nur das Endergebnis (in den einzelnen Wettbewerben in einer Reihe von Veranstaltungen im Tischtennis-Match oder bestimmten Sätzen von Tischtennis-Match) war. Sindik (1999) gibt einen Überblick der Variablen, die direkt aus den Ergebnissen des Wettbewerbs abgeleitet werden können, jedoch konnten diese Variablen nur auf eine kleinere

Anzahl von Indizes reduziert werden. In früheren Studien (Sindik, 1999, Sindik und Juričević, 2007) stellten wir fest, dass die meisten Interkorrelationen zwischen dem Index und den Interkorrelationen zwischen den Variablen der Leistungswirksamkeit im Tischtennis mäßig hoch waren. Das Hauptziel dieser Studie war es zu bestimmen, in welchem Ausmaß durch die Indizes, die direkt aus den Ergebnissen der Wettbewerbe im Tischtennis abgeleitet sind, Indizes vorhergesagt werden können, die das Endergebnis eines einzelnen Spielers in einer Reihe von einzelnen Tischtennis-Spielen beschreiben. Die Ziele der Forschung haben ergeben: die Korrelation zwischen den einzelnen Variablen der Leistungs-Effizienz zu bestimmen (1), die Korrelation zwischen den einzelnen Variablen der Leistungs-Effizienz im Tischtennisspiel mit dem Effizienz-Index, abgeleitet durch die Summierung der Anzahl der Variablen (2), die Korrelation zwischen einzelnen Variablen in der Leistungs-Effizienz im Tischtennis, mit dem Gesamt-Performance-Index (3), die Fähigkeit, den Index und die Variablen vorauszusehen: der Index entspricht den Index-Sets, dem allgemeine Effizienz-Index, auf Grund der restlichen Indizes und anderen Variablen der Wettbewerbsfähigkeit in Tischtennis und Protokoll-Variablen (4).

Die Forschung beinhaltet eine Analyse einer Stichprobe von 956 Tischtennis-Spielern, die sich an 20 rekreativen Tischtennis-Ligen (SOKAZ) und an mindestens 6 einzelnen Spielen während der Meisterschaft im Jahr 2007 bewarben. Wir haben die Variablen direkt aus den Ergebnissen der Tischtennis-Wettbewerbsspiele definiert. Die abhängigen Variablen, bzw. Kriterien (in der Regressionsanalyse) waren direkte Indikatoren für Wirksamkeit: gewonnene Matches und Sätze. Unabhängige Variablen (Prädiktoren) waren indirekte Indikatoren für die Wirksamkeit: die verlorenen Matches und Sätze, die Siege und Niederlagen in Sätzen, die für die Punkte-Differenz gespielt wurden, Siege und Niederlagen in 5-Satz-Matches, und gewonnene und verlorene Matches nach 0-2 in Sätzen zu Gunsten des Gegners. Die Protokoll-Variablen waren die Anzahl der gespielten Matches, Sätze, Spiele mit einem Twist, 5-Satz-Matches, Sätze mit Punkte-Differenz. Indizes sind Kombinationen von zwei einzelnen Variablen, bzw. das Verhältnis zwischen erfolgreich erreichten und maximal möglicher Anzahl von Fällen, in Bezug auf Indikatoren der Leistung in Wettbewerbssituationen. Die Daten wurden von der offiziellen Webseite der Organisation der Tischtennis-Clubs und Club-Aktiven von Zagreb (SOKAZ - www.sokaz.hr) gesammelt, von 2 Meisterschaften im Jahr 2007 (Frühjahr und Herbst Saison Meisterschaft), für verschiedene Ränge des Wettbewerbs, in dem die Teams kämpften. Die Datenanalyse wurde mit dem Programmpaket SPSS 15.0 durchgeführt. Neben der deskriptiven Statistik wurden Pearson-Korrelationen berechnet, um die Korrelation zwischen allen Indizes und Variablen zu bestimmen. Vollständige multiple Regressionsanalyse wurde verwendet, um die Prognose von Kriterium-Variablen zu berechnen: das Index-Match, die Index-Sätze, der Index der Gesamtleistung, gewonnene Matches und Sätze.

Die Ergebnisse zeigten, dass alle Korrelationen zwischen einzelnen Variablen und der Index-Leistungseffizienz der Tischtennis-Wettkämpfe statistisch signifikant sind. Der Gesamt-Indexwirkungsgrad ist signifikant höher und moderat positiv mit allen wichtigen Variablen verbunden, die die Indikatoren für die Leistungs-Effizienz sind: gewonnene Matches, gewonnene Matches nach dem Resultat 0-2 in Sätzen für den Gegner, gewonnene Sets mit Punkte-Differenz, gewonnene Matches in fünf Sätzen. Wir fanden mittlere bis hoch positive und statistisch signifikante Korrelationen zwischen allen direkten und indirekten Indikatoren für die Tischtennisleistungs-Effizienz. Die Indices und die Variablen, die direkt aus den Ergebnissen abgeleitet wurden, können statistisch signifikant mit Hilfe von Index und Variablen des Enderfolgs im Wettbewerb vorhergesagt werden: das Index-Match, die Index-Sets, die gewonnenen Matches und die gewonnenen Sätze. Die Protokoll-Variablen können erheblich den gesamten Effizienz-Index prognostizieren. Das Hauptergebnis der Untersuchung ist der Befund, dass selbst bei einer kleinen Anzahl von Index-Variablen eine statistisch signifikante Korrelation mit End-Erfolg in Tischtennis Spielen (gewonnenes Spiel oder Set) gefunden werden kann. Alle direkten und indirekten Effizienz--Indizes sind negativ (wenn auch gering) mit dem Niveau der Wettbewerbsliga und in "leistungs-schwächeren" Ligen haben diese Indizes niedrigere Werte. Dies kann indirekt auf die Tatsache über die verschiedenen Unsicherheiten des Wettbewerbs in "stärkeren" oder "schwächeren" Ligen zurückgeführt werden. Auf Grund der Ergebnisse kann man vorsichtig annehmen, dass der Sieg mit Punkte-Differenz in Sätzen und die damit verbundenen Variablen und Indizes sowie der Gewinn im Spiel in fünf Sätzen von kritischen Ereignissen für den endgültigen Ausgang des Spiels sein mag. Daher sollte den Tischtennis-Spielern und ihren Trainern suggeriert werden, die Aufmerksamkeit auf die Aufrechterhaltung psychischer Stabilität und die Stabilität der Leistung gerade in diesen Situationen zu lenken.

Schlüsselwörter: Analyse, Wettbewerb, Prognose, Spiele mit Schlägern

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STRUKTURA IZOLOVANIH FAKTORA PRECIZNOSTI ODBOJKAŠA

STRUCTURE OF ISOLATED PRECISION FACTORS OF THE MALE VOLLEYBALL PLAYERS

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SUMMARY

The subject of this research project is precision as a factor of success of the male volleyball players. The issue relates to the realization of the said motor skills through a clearly defined and valid metric tests typical for the area of technical - tactical structure of volleyball. The aim of the study was to determine the factorial structure of motor abilities of precision for male volleyball players. The task was to determine the correlation between motor tasks with the main components defined as potential factors of the research area. The sample consisted of 40 male volleyball players, members of volleyball teams from Niš (SRB), 14-16 years of age. Eleven motor tests were used to assess the following potential factors: the precision of shooting targets in the horizontal plane, the precision of shooting targets in the vertical plane, body coordination at the volleyball court, the precision of spike technique and nerve-muscle reactions.

It was found that there are certain manifest dimensions within the subjects area defined as the area of precision. Then, in the structure of this area of volleyball, acting as precision factors in shooting targets with fingers and "bump" in the horizontal and vertical plane, also confirmed that the coordination of work and factor in the space of volleyball court and a velocity factor of nerve-muscle response.

In general it is concluded that within the structure of technical-tactical elements operates particular type of precision in volleyball, that can be defined as factors of precision in the technique of adding a ball with fingers, forearm pass technique ("bump") and spike technique.

Key words: technical-tactical stuctures, factors, precision, volleyball.

SAŽETAK

Predmet ovog istraživanja jeste preciznost kao faktor uspješnosti kod odbojkaša. Problem se odnosi na realizaciju pomenute motoričke sposobnosti putem jasno definisanih i metrijski validnih testova karakterističnih za prostor tehničko–taktičke strukture odbojke. Cilj u istraživanju je da se utvrdi faktorska struktura antropomotoričke sposobnosti preciznosti za odbojkaše. Zadatak je utvrditi stepen korelacije motoričkih zadataka sa glavnim komponentama definisanim kao potencijalni faktori istraživanog prostora. Uzorak ispitanika činilo je ukupno 40 odbojkaša članova odbojkaških klubova iz Niša (SRB), starosti od 14 do 16 godina. Korišteno je 11 motoričkih testova za procjenu sljedećih potencijalnih faktora: preciznost pogađanja ciljeva u horizontalnoj ravni, preciznost pogađanja ciljeva u vertikalnoj ravni, koordinacija tijela na odbojkaškom terenu, preciznost tehnike smečiranja i nervno mišićna reakcija.

Utvrđeno je da postoje određene manifestne dimenzije unutar posmatranog prostora definisanog kao prostor preciznosti. Zatim, da u strukturi ovog prostora kod odbojkaša, djeluju faktori preciznosti pogađanja ciljeva prstima i "čekićem" u horizontalnoj i vertikalnoj ravni, također je potvrđeno da djeluju i faktor koordinacije u prostoru odbojkaškog terena i faktor brzine nervno-mišićnog reagovanja.

Generalno je zaključeno da u strukturi tehničko-taktičkih elemenata djeluju posebni tipovi preciznosti odbojkaša koji se mogu definisati kao faktori preciznosti u tehnici dodavanja lopte prstima, tehnici dodavanja "čekićem" i tehnici smečiranja.

Ključne riječi: tehničko-taktička struktura, faktori, preciznost, odbojka.

INTRODUCTION

In every sporting activity, even in volleyball, there is no technical element that can be properly carried out without adequate motor skills, nor can any motor ability be fully manifested without rational technique. So it is inconceivable to talk about the development and improvement of motor skills in isolation from the development and refinement of motor skills and habits. This research paper considered the application of precision motor ability tests based on all the existing knowledge about relationship of motor ability and motor skills. The idea is to congregate in one place material facts associated with a specific motor skill, such as precision.

The issues related to precision are studied by many authors. Their findings cover mainly the area of the structure of outplaying by female volleyball players and male volleyball players and solving motor tasks in situational training or volleyball competition. (Бернстеин, 1990; Gajić, 2005; Janković, 1988; Karalić, 2007; Ляхова & Стрельникова, 2007; Немцев, 2003; Nešić, 2006; Stojanović & Milenkoski, 2005). Most papers dealt with problems in terms of only some parts of the game structure, or discuss the factors which are directly or indirectly related to the structure of competitive activity.

One of the important questions that permeates through the research conducted so far is the question of reliability and validity of tests for the so-called situational-motor precision and situational-motor tests in volleyball. (Strahonja 1978; Strahonja, Janković & Šnajder, 1982).

In the manifest and latent motor area, the precision is defined as a special volleyball skill. In the latent motor area, there are two modes of motor precision: precision of shooting and precision of targeting. (Janković, 1988; Stojiljković, 2003). Precision of shooting is characteristic for volleyball. If we are already talking about the types of volleyball precision, let us also add what particularly stand out: precision of adding with fingers, precision of adding with the forearms, serving precision and spike precision (Bosnar & Šnajder, 1983; Horga, Momirović, & Janković, 1983). So it appears as an integral part of all elements of the TT elements (serving, spike, settings, block, services reception and defense).

So, the subject of this research is the precision as factor of success of male volleyball players. The specific problem relates to the implementation of the precision of motor skills through clearly defined and valid metric tests characteristic of the space technical - tactical structure of volleyball. The aim of the research was to determine the factor structure of

UVOD

U svakoj sportskoj aktivnosti, pa i u odbojci, nijedan tehnički elemenat se ne može korektno izvesti bez adekvatne motoričke sposobnosti, niti se motorička sposobnost može u cijelosti ispoljiti bez racionalne tehnike. Dakle, nezamislivo je govoriti o razvoju i usavršavanju motoričkih sposobnosti odvojeno od razvoja i usavršavanja motoričkih znanja i navika. U radu je posmatrana motorička sposobnost preciznost primjenom testova za njenu procjenu, rukovodeći se pri tom svim prethodnim saznanjima o postojanju uzajamno – posljedične veze motoričkih sposobnosti i motoričkih znanja. Ideja je da se na jednom mjestu sakupe značajne činjenice povezane sa specifičnom motoričkom sposobnosti kao što je preciznost.

Problem preciznosti istraživali su mnogi autori. Njihova saznanja obuhvatala su uglavnom područje strukture nadigravanja kod odbojkaša ili odbojkašica i rješavanje motoričkih zadataka na situacionom treningu ili odbojkaškom takmičenju (Бернстеин, 1990; Gajić, 2005; Janković, 1988; Karalić, 2007; Ляхова і Стрельникова, 2007; Немцев, 2003; Nešić,2006; Stojanović і Milenkoski, 2005). U većini radova rješavaju se problemi samo nekih dijelova strukture igre, ili se razmatraju faktori koji su posredno ili neposredno vezni za strukturu takmičarske aktivnosti.

Jedno od značajnih pitanja, koje se prožima kroz do sada provedena istraživanja, jeste pitanje pouzdanosti i valjanosti testova za tzv. situaciono-motoričku preciznosti i situaciono-motoričkih testova u odbojci (Strahonja 1978; Strahonja, Janković і Šnajder, 1982).

U manifestnom i latentnom antropomotoričkom prostoru preciznost je definisana kao specijalna odbojkaška sposobnost. U latentnom prostoru motorike izdvojena su dva načina motoričke preciznosti: preciznost gađanjem i preciznost ciljanjem (Janković, 1988; Stojiljković, 2003). Za odbojku je karakteristična preciznost gađanjem. Ako već govorimo o vrstama odbojkaške preciznosti, dodajmo i to da se posebno izdvajaju: preciznost odbijanja i dodavanja prstima, preciznost odbijanja i dodavanja podlakticama, preciznost serviranja i preciznost smečiranja (Bosnar і Šnajder, 1983; Horga, Momirović і Janković, 1983). Dakle, pojavljuje se kao sastavni dio svih TT elemenata (serviranje, smečiranje, dizanje lopte, blokiranje, prijem servisa i odbrane u polju).

Predmet ovog istraživanja jeste preciznost kao faktor uspješnosti kod odbojkaša. Konkretan problem odnosi se na realizaciju motoričke sposobnosti preciznosti putem jasno definisanih i metrijski validnih testova karakterističnih za prostor tehničko – taktičke strukture odbojke. Cilj u istraživanju je da se utvrdi

motor abilities of precision for male volleyball players. The task is to determine the correlation between motor tasks with the main components, defined as potential factors of the study area for male volleyball players.

METHODS

Entitiy sample

The sample consisted of 40 male volleyball players members of volleyball teams from Niš ("Niš", "As", and "Student"). The subjects in the sample were 14 to 16 years old male volleyball players from the selection of cadets, with an average of 4−6 years of training program. The sample is interesting because it is about the age and period when they move from the universal model of play to the specialized model. It is time when we are trying to find their appropriate functions, taking into consideration also the features, characteristics and especially the abilities of cadet male volleyball players, who are undoubtedly, closely connected with the realization of the success on tests of precision.

Variables sample

In this reaserch eleven motor tests were used to assess the following potential factors: precision of shooting targets in the horizontal plane, precision of shooting targets in the vertical plane, the coordination of body at the volleyball court, precision of spike techniques, muscular and nervous reactions.

Motor tests are defined as follows: shooting the horizontal target with fingers (SHTF); shooting the horizontal target with the forearms (SHTB); shooting the vertical target with fingers (SVTF); shooting the vertcal target with "bump" (SVTB); shooting the target in the horizontal plane from position 2 (STHP2); shooting the horizontal target with spike technique (SPIKE); one-hand juggling a ball through a hoop (OHJ); test coordination by the volleyball net (KOONET); test coordination in the space (KOOSP); hexagon test (HEX) and test falling rod (REFL).

Statistical analysis

To process the obtained data we used methods of descriptive statistics and factor analysis. The structure of motor precision was determined by Hotelling's method of principal components. Number of significant principal components was determined by using Gutman-Kraiser's criteria. Correlation analysis was used to measure the correlation between the applied motor tests with the main components defined as a potential factors of precision area for male volleyball players.

faktorska struktura antropomotoričke sposobnosti preciznosti za odbojkaše. Zadatak je utvrditi stepen korelacije motoričkih zadataka sa glavnim komponentama definisanim kao potencijalni faktori istraživanog prostora kod odbojkaša.

METODE

Uzorak ispitanika

Uzorak ispitanika činilo je ukupno 40 odbojkaša članova odbojkaških klubova iz Niša ("Niš", "As" i "Student"). Starost ispitanika u uzorku je od 14 do 16 godina. Radi se o odbojkašima kadetskog uzrasta, koji treniraju u prosjeku 4 do 6 godina. Uzorak je interesantan jer je riječ o uzrastu i periodu u kojem se iz univerzalnog modela igranja prelazi na specijalizovani model. Tada se nastoji pronaći odgovarajuća igračka funkcija u odnosu na osobine, karakteristike i naročito sposobnosti odbojkaša kadeta, koje su, nesumnjivo, usko povezane sa realizacijom uspješnosti na testovima preciznosti.

Uzorak varijabli

U ovom istraživanju korišteno je 11 motoričkih testova. Primijenjeni su motorički testovi za procjenu sljedećih potencijalnih faktora: preciznost pogađanja ciljeva u horizontalnoj ravni, preciznost pogađanja ciljeva u vertikalnoj ravni, koordinacija tijela na odbojkaškom terenu, preciznost tehnike smečiranja i nervno mišićna reakcija.

Motorički testovi su definisani na sljedeći način: pogađanje horizontalnog cilja prstima (SHTF), pogađanje horizontalnog cilja podlakticama (SHTB), pogađanje vertikalnog cilja prstima (SVTF), pogađanje vertikalnog cilja "čekićem" (SVTB), pogađanje horizontalnog cilja u poziciji 2 (STHP2), pogađanje horizontalnog cilja smečiranjem iz skoka (SPIKE), jednoručno žongliranje loptom kroz obruč (OHJ), test koordinacije uz mrežu (KOONET), test koordinacije u prostoru (KOOSP), heksagon test (HEX) i test padajući štap (REFL).

Statistička analiza

Za obradu dobijenih podataka, koristili su se postupci deskriptivne statistike i faktorske analize. Struktura motoričke preciznosti utvrđena je Hotelingovom metodom glavnih komponenti. Broj značajnih glavnih komponenti određen je pomoću Gutman-Kraiserovog kriterijuma. Korelaciona analiza upotrebljena je kako bi se utvrdila povezanost primijenjenih motoričkih testova sa glavnim komponentama definisanim kao potencijalni faktori prostora preciznosti za odbojkaše.

RESULTS AND DISCUSSION

Basic statistical parameters of male volleyball players

Regarding Table 1, the arithmetic mean (*M*) at the sample of male volleyball players ($n = 40$) and for the motor test shooting the horizontal target with fingers (SHTF) was 15.0 ± 1.09, for shooting the horizontal target with the "bump" (SHTB) was 9.35 ± 1.93, for motor test shooting the vertical target with fingers (SVTF) the Mean is 20.07 ± 2.27 and for the motor test shooting the vertcal target with "bump" (SVTB) it was 10.95 ± 1.20. For the motor test shooting the target in the horizontal plane from position 2 (STHP2) the Mean was 9.93 ± 1.53. For sample of male volleyball players the Mean of motor tests shooting the

REZULTATI I DISKUSIJA

Osnovni statistički parametri odbojkaša

U Tabeli 1, aritmetička sredina (M) na nivou uzorka odbojkaša ($n = 40$) motoričkog testa pogađanje horizontalnog cilja prstima (SHTF) iznosi 15,00 ± 1,09, za motorički test pogađanje horizontalnog cilja "čekićem" (SHTB) iznosi 9,35 ± 1,93, za motorički test pogađanje vertikalnog cilja prstima (SVTF) aritmetička sredina je 20,07 ± 2,27 i za motorički test pogađanje vertikalnog cilja "čekićem" (SVTB) ona iznosi 10,95 ± 1,20. Za motorički test pogađanje horizontalnog cilja u poziciji 2 (STHP2) aritmetička sredina je 9,93 ± 1,53. Kod uzorka odbojkaša vrijednosti aritmetičih sredina motoričkih testova pogađanje

TABLE 1

Basic statistical parameters of the male volleyball players.

TABELA 1

Osnovni statistički parametri odbojkaša.

Variable	*M*	*MIN*	*MAX*	Var. width	*SD*	*SE*	Skew.	Kurt.
SHTF	15.00	13.00	17.00	3.66	1.09	.17	.38	-.45
SHTB	9.35	4.00	14.00	5.18	1.93	.30	-.50	1.12
SVTF	20.07	17.00	28.00	4.84	2.27	.36	1.25	2.33
SVTH	10.95	8.00	13.00	4.16	1.20	.19	-.28	-.40
STHP2	9.93	7.00	14.00	4.57	1.53	.24	.73	.38
SPIKE	18.32	12.00	21.00	5.02	1.79	.28	-1.14	2.45
OHJ	12.77	10.00	15.00	3.47	1.44	.23	-.02	-1.19
KOONET	5.93	5.13	7.13	4.44	.45	.07	.74	.06
KOOSP	7.93	6.78	9.40	4.76	.55	.09	.49	.24
HEX	22.82	20.93	25.60	4.86	.96	.15	.64	1.46
REFL	15.65	14.00	17.50	3.50	1.00	.16	-.05	.77

Legend: ***M*** - Sample mena (Aritmetička sredina); ***MIN*** - Minimum value (Najmanja vrijednost); ***MAX*** - Maximum value (Najveća vrijednost); **Var. width** - Variational width (Varijaciona širina); ***SD*** - Standard deviation (Standardna devijacija); ***SE*** - Standard error (Standardna greška); **Skew**. - Coeffcients of skewness (Koeficijent spljoštenosti); **Kurt.** – Coeffcients of kurtosis (Koeficijent izduženosti); **SHTF** - Shooting the horizontal target with fingers (Pogađanje horizontalnog cilja prstima); **SHTB** - Shooting the horizontal target with the "bump" (Pogađanje horizontalnog cilja "čekićem"); **SVTF** - Shooting the vertical target with fingers (Pogađanje vertikalnog cilja prstima); **SVTH** - Shooting the vertcal target with "bump" (Pogađanje vertikalnog cilja "čekićem"); **STHP2** - Shooting the target in the horizontal plane from position 2 (Pogađanje horizontalnog cilja u poziciji 2); **SPIKE** - Shooting the horizontal target with spike technique (Pogađanje horizontalnog cilja smečiranjem iz skoka); **OHJ** - One-hand juggling a ball through a hoop (Jednoručno žongliranje loptom kroz obruč); **KOONET** - Coordination by the volleyball net (Koordinacija uz mrežu); **KOOSP** - Coordination in the space (Koordinacije u prostoru); **HEX** - Hexagon test (Heksagon test); **REFL** - Falling rod (Padajući štap).

horizontal target with spike technique (SPIKE) was 18.2 ± 1.79 and for motor tests one-hand juggling a ball through a hoop (OHJ) was 12.77 ± 1.44. The Mean of motor tests coordination by the volleyball net (KOONET) were 5.93 ± .45 and coordination in the space (KOOPRO), 7.93 ± .55. The Mean of test hexagon test (HEX) to measure agility was 22.82 ± .96 and motor tests to assess reaction time: a test falling rod (REFL) 15.65 ± 1.00.

Variational width (Var. width) ranging from minimum (*MIN*) to maximum (*MAX*) value is less than 6 or (± 3) standard deviations. A sample of volleyball players was selected by the quality of execution of technical elements, in accordance to age categories, limited to the Mean, so there is no distinctly below average, or above average results.

The values of skewness (Skew.) and kurtosses (Kurt.) distribution of the results for the entire sample of male volleyball players are generally within the normal distribution. Only the results for the motor test shooting the vertical target with fingers (SVTF), go beyond the normal distribution and show a small positive asymmetry (1.25). Certain deviations were observed in the motor test shooting the horizontal target with spike technique (SPIKE), whose value of skewness (-1.14) showed a small negative asymmetry. According to the results of the degree of curvature, or the value of kurtosis, it is estimated that homogeneity of results exists in the performance of motor tests. Given that it is about slightly longer and lower values of symmetry in the two above-mentioned motor tests, it is considered that as such they do not disturb the further processing of data, so that further statistical analysis can be safely continued, as well as the analysis of comparative statistics, and analysis of precision space of male volleyball players.

It is noticeable that most motor tests in which the technique of passing the ball with fingers was mostly used had a better and higher value. The only exception is motor test for shooting the vertical target with fingers where the results show a variation on normal distribution, and a small negative asymmetry. Based on this value it can be said that this motor test was more demanding on some of the respondents from the sample male volleyball players and that their Mean is in area of lower values.

If we look to the tests in which a technique of adding with "bump" was used, in the realization of these tests the sample of volleyball players has achieved excellent results, and have the higher mean values. Despite this, in tests which use the forefinger manipulation with the ball, male volleyball players have better results compared to the results in tests in which they used technique of adding with "bump".

horizontalnog cilja smečiranjem iz skoka (SPIKE) je 18,32 ± 1,79 i motoričkog testa jednoručno žongliranje loptom kroz obruč (OHJ) je 12,77 ± 1,44. Aritmetičke sredine motoričkih testova koordinacije uz mrežu (KOONET) su 5,93 ± 0,45 i koordinacije u prostoru (KOOPRO) 7,93 ± 0,55. Aritmetička sredina Heksagon testa (HEX) kojim se mjeri agilnost iznosi 22,82 ± 0,96 i motoričkog testa za procjenu vremena reakcije: padajući štap (REFL) 15,65 ± 1,00.

Varijaciona širina (Var. šir.) u rasponu od minimalnih (*MIN*) ka maksimalnim (*MAX*) vrijednostima iznosi manje od 6 ili (±3) standardne devijacije. Uzorak iz populacije odbojkaša je odabran prema kvalitetu izvođenja tehničkih elemenata u skladu sa uzrasnom kategorijom, ograničen je na srednje vrijednosti, tako da u njemu nema izrazito ispodprosječnih, kao ni izrazito nadprosječnih rezultata.

Vrijednosti simetričnosti (Skew.) i spljoštenosti (Kurt.) distribucija rezultata za cijeli subuzorak odbojkaša su uglavnom u granicama normalne distribucije. Jedino motorički test pogađanje vertikalnog cilja prstima (PRVER) izlazi iz okvira normalne distribucije i pokazuje malu pozitivnu asimetričnost (1,25). Određena odstupanja su primijećena i kod motoričkog testa pogađanje horizontalnog cilja smečiranjem iz skoka (SPIKE) čija je vrijednost skjunisa (-1,14) i pokazuje malu negativnu asimetričnost. Prema rezultatima stepena zakrivljenosti, odnosno vrijednostima kurtosisa, procijenjeno je da postoji potrebna homogenost rezultata u izvođenju motoričkih testova. S obzirom da se radi o neznatnim većim i manjim vrijednostima simetričnosti u dva pomenuta motorička testa, smatra se da one kao takve ne remete dalju obradu podataka, tako da se sa sigurnošću može pristupiti daljoj statističkoj obradi, kako u analizi komparativne statistike, tako i u analizi prostora preciznosti odbojkaša.

Uočljivo je da većina motoričkih testova u kojima preovladava tehnika dodavanja prstima imaju bolje i veće vrijednosti. Od ove tvrdnje ipak odstupa motorički test pogađanje vertikalnog cilja prstima koji izlazi iz okvira normalne distribucije i pokazuje malu pozitivnu asimetričnost. Na osnovu te vrijednosti može se reći da je kao motorički test bio zahtjevniji za neke od ispitanika iz uzorka odbojkaša i da se njihova aritmetička sredina nalazi u zoni manjih rezultata.

Osvrćući se samo na testove u kojima se koristila tehnika odbijanja lopte "čekićem", u realizaciji tih testova odbojkaši su postigli odlične rezultate, te su i vrijednosti aritmetičkih sredina ovih testova u zoni većih. No i pored toga, odbojkaši u testovima u kojima dolazi do izražaja manipulacija lopte prstima, imaju bolje rezultate u odnosu na rezultate koje su postigli u testovima u kojima se koristila tehnika odbijanja lopte podlakticama ili "čekićem".

Motor tests of shooting the horizontal target with spike technique and one-hand juggling a ball through a hoop have a higher mean value, which indicates that the male volleyball players are generally very good in spike technique performance in which explosive power and speed of individual arm movements are dominant, as well as a skill in one-hand juggling a ball through a hoop. This is further supported by the value of skewness in the motor test of shooting the horizontal target with spike technique which shows a small positive asymmetry. We conclude that as a motor test this was relatively easy for some of the sample male volleyball players and their average values are significant.

Kalajdžić (1984) came to the similar conclusion in his research paper on the structure of the volleyball games and found that when it comes to the efficient expression technique, an explosive leg strength and speed of individual arm movements at spike have the greatest impact, as well as the whole body coordination and flexibility. Bertucci and Hippolyte (1984) based on the obtained data, have concluded that in the training process training techniques should exist as well as the necessary physical ability that should be developed (vertical jump, speed in all its manifestations). Male volleyball players have shown that they possess a high degree of coordination skills in the implementation of tests, because the results of coordination tests by the volleyball net and coordination in space are within higher test results. This coordination is manifested through a distinct coordination of arms and legs.

Current research papers of coordination clearly indicate the importance of this ability, and that it can be expressed through different forms. Horga et al. (1973) dealt with the issue of the existence of specific forms of motor coordination as well, which can certainly be associated with this research, and they established the existence of a single common factor of measurement, called hand coordination factor. Viskić Štalec et al. (1973) also found a common factor of measurement and interpreted it as the ability of coordination in performing complex motor tasks, using mainly the lower extremities.

Because of the complexity of the tasks set in this research, but also specifics of the sample (male volleyball players), without a doubt we can talk not only about the coordination of upper and lower extremities, but also the coordination of the whole body. Given that the emphasis is placed on the complexity of coordination, the relationship between cognitive ability (intelligence), and coordination is very important. This motor ability correlates highly with intelli-

Motorički testovi pogađanje horizontalnog cilja smečiranjem iz skoka i jednoručno žongliranje loptom kroz obruč imaju aritmetičke sredine u zoni većih vrijednosti, što ukazuje na to da su odbojkaši generalno vrlo dobri u izvođenju tehnike smečiranja, u kojoj dominantno mjesto imaju eksplozivna snaga i brzina pojedinačnih pokreta ruku, odnosno, spretni u žongliranju loptom jednom rukom kroz obruč. Argument više za to je vrijednost skjunisa kod testa pogađanje horizontalnog cilja smečiranjem iz skoka koji pokazuje malu negativnu asimetričnost. Konstatujemo da je kao motorički test bio relativno lak za neke od ispitanika iz uzorka odbojkaša i da se njihove prosječne vrijednosti nalaze u zoni većih rezultata.

Do sličnog zaključka došao je Kalajdžić (1984) u svom istraživanju strukture odbojkaške igre i utvrdio da od motoričkih sposobnosti najveći uticaj na efikasno ispoljavanje tehnike ima eksplozivna snaga nogu i brzina pojedinačnih pokreta ruku kod smečera, ali i koordinacija cijelog tijela i fleksibilnost. Bertucci i Hippolyte (1984) su na osnovu dobijenih podataka, zaključili da u trenažnom procesu treba da postoji ne samo usavršavanje tehnike, već i razvoj neophodnih fizičkih sposobnosti (skočnost, brzina u svim svojim manifestacijama). Odbojkaši su pokazali i to da posjeduju visok stepen koordinacionih sposobnosti pri realizaciji testova, jer se rezultati testova koordinacije uz mrežu i koordinacije u prostoru nalaze u zoni boljih rezultata. Ta koordinacija manifestovala se kroz izrazitu koordinaciju ruku i nogu.

I dosadašnja istraživanja prostora koordinacije nedvosmisleno govore o važnosti ove sposobnosti, te da se može ispoljiti kroz nekoliko različitih oblika. Problemom postojanja specifičnih oblika motoričke sposobnosti koordinacije, a što se svakako može dovesti u vezu sa ovim istraživanjem, bavili su se Horga i saradnici (1973), koji su utvrdili postojanje jedinstvenog zajedničkog predmeta mjerenja kojeg su nazvali faktor koordinacije ruku. Također, Viskić Štalec i saradnici (1973) su svojim istraživanjem utvrdili zajednički predmet mjerenja i interpretirali ga kao sposobnost koordinativnog izvođenja kompleksnih motoričkih zadataka, pretežno upotrebom donjih ekstremiteta.

Zbog složenosti postavljenih zadataka ovog istraživanja, ali i specifičnosti ispitivanog uzorka (odbojkaši), bez sumnje se može govoriti ne samo o koordinaciji gornjih i donjih ekstremiteta, nego i o koordinaciji cijelog tijela. Obzirom na to da je akcenat stavljen na složenost koordinacije, sam po sebi kao vrlo važan nameće se odnos između kognitivnih sposobnosti (inteligencije) i koordinacije. Ova motorička sposobnost visoko korelira sa inteligencijom i nemoguće

gence and it is impossible to define or analyze coordination independently of intellectual abilities. The arguments for this assertion are the results of multiple studies (Ismail & Gruber, 1967; Ismail, Kane, & Kirkendal, 1976; Mejovšek, 1977; Momirović, Dobrić, & Karaman, 1984) which show that the relationship between intellectual and motor abilities are, in the first place the results of common factors that affect on the variability intellectual skills and coordination.

Relations between intellectual ability and coordination tests of movement were analyzed mainly with regression model, canonical analysis of variance (Momirović et al., 1983), or model of overlapping analysis, but the most commonly used was canonical correlation analysis (Mejovšek, 1977). The value of Mean for the motor test hexagon for a sample of

je koordinaciju definisati ili analizirati nezavisno od intelektualnih sposobnosti. Argumenti za takvu tvrdnju su rezultati većeg broja istraživanja (Ismail i Gruber, 1967; Ismail, Kane i Kirkendal, 1976; Mejovšek 1977; Momirović, Dobrić i Karaman, 1984) koji su upravo pokazali da je povezanost između intelektualnih i motoričkih sposobnosti u prvom redu posljedica zajedničkih činilaca koji utiču na varijabilitet intelektualnih sposobnosti i koordinaciju pokreta.

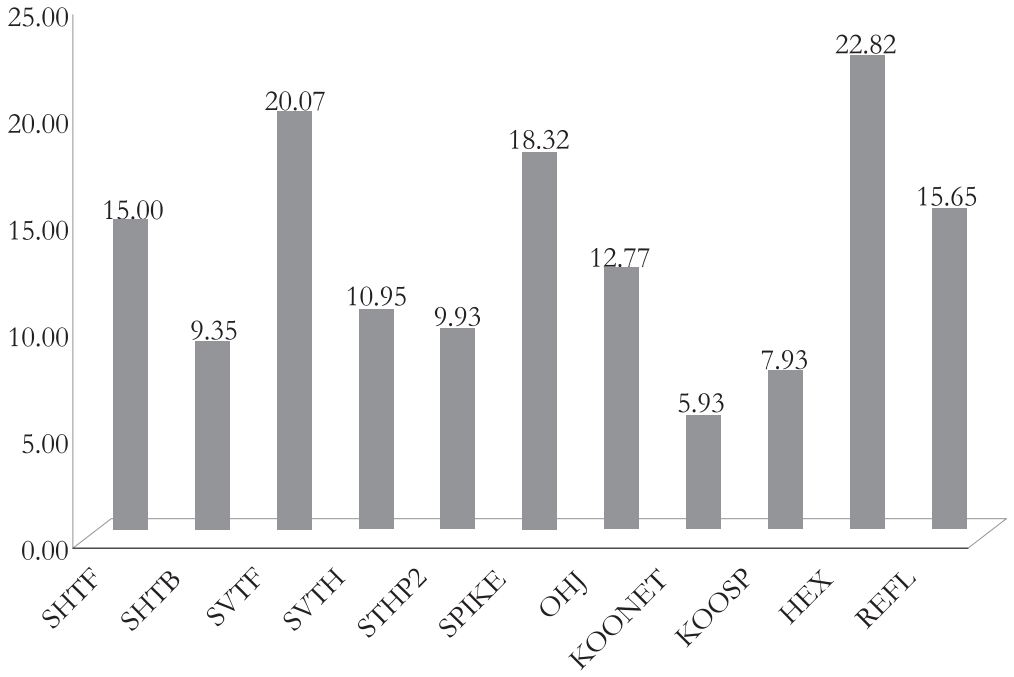
Relacije između intelektualnih sposobnosti i testova koordinacije pokreta analizirane su uglavnom regresionim modelom, modelom kanoničke analize varijansi (Momirović i saradnici, 1983), modelom analize prepokrivanja, a najčešće modelom kanoničke korelacione analize (Mejovšek, 1977). Vrijednost aritmetičke sredine motoričkog testa Heksagon za

FIGURE 1

Graphic presentation of average values of the applied tests of the male volleyball players.

SLIKA 1

Grafički prikaz prosječnih vrijednosti primjenjenih testova kod odbojkaša.



Legend: **SHTF** - Shooting the horizontal target with fingers (Pogađanje horizontalnog cilja prstima); **SHTB** - Shooting the horizontal target with the "bump" (Pogađanje horizontalnog cilja "čekićem"); **SVTF** - Shooting the vertical target with fingers (Pogađanje vertikalnog cilja prstima); **SVTH** - Shooting the vertcal target with "bump" (Pogađanje vertikalnog cilja "čekićem"); **STHP2** - Shooting the target in the horizontal plane from position 2 (Pogađanje horizontalnog cilja u poziciji 2); **SPIKE** - Shooting the horizontal target with spike technique (Pogađanje horizontalnog cilja smečiranjem iz skoka); **OHJ** - One-hand juggling a ball through a hoop (Jednoručno žongliranje loptom kroz obruč); **KOONET** - Coordination by the volleyball net (Koordinacija uz mrežu); **KOOSP** - Coordination in the space (Koordinacije u prostoru); **HEX** - Hexagon test (Heksagon test); **REFL** - Falling rod (Padajući štap).

male volleyball players is high, which implies poorer overall results, after the implementation of this test.

We note that in this test the subjects were not able to attempt a trial, and reasons for the poor results can also be related to this. We can confirm that the cause of poor results was low level of concentration during the test, reduced anaerobic-aerobic endurance, and slow performance of jumps with both feet. This was further affected by fatigue during performance, and by insufficient emotional stability.

Unlike the hexagon test (HEX) results of the mean value of the motor test falling rod (REFL) is higher, and this points us to the conclusion that the male volleyball players in this test were quite successful in the realization of the task, and also they had the necessary level of concentration attention without disruptive factors, the coordination of arm movements and speed of reaction.

This is further supported by Vuković (1996), who found that in male volleyball players there are significant differences in morphological characteristics (body height, body weight, arm length, pelvic width, the width of the hand, volume shin, volume forearm) but also in latent space (longitudinal dimensions of the skeleton). In the structure of motor abilities two latent dimensions stand out, and these are explosive power and agility.

Factor structure of space precision by male volleyball players

Table 2 shows the values of the coefficient of discrimination (Eigenvalue). According to the values of the coefficient of discrimination (value >1) four main components were isolated which explain 61.05% of common variance (Total Variance%) of the whole system for a sample of volleyball players. The first component explains 19.64% of common variance, the second component explains 15.36% of common variance, the third component of 14.30% and fourth component only 11.76% of common variance. Communalities are presented together with significant principal components.

Table 3 shows precision space structures by male volleyball players, in fact it shows correlation of applied motor tasks with the four main components defined as factors of the researched area. Factor values higher than .304 are marked.

Respecting the hierarchy of isolated factors and the level of explanation of the total variance, the first factor (F1) in volleyball players is defined as the precision of shooting a target with "bump". The second factor (F2) is defined as a body coordination in the volleyball court. The third factor (F3) is defined as the precision of shooting a target with fingers. And fourth, last factor (F4), which explains the smallest

uzorak odbojkaša je u zoni većih vrijednosti, što implicira slabije rezultate ukupne realizacije ovog testa.

Napominjemo da kod ovog testa nije bilo mogućnosti probnog pokušaja, te se u tome trebaju tražiti razlozi slabih rezultata. Sa sigurnošću možemo tvrditi i to da je uzrok slabih rezultata nizak nivo koncentracije u toku izvođenja testa, smanjena anaerobno-aerobna izdržljivost, te spor tepmo izvođenja sunožnih skokova. Na takvo stanje su dodatno uticali zamor u toku izvođenja i nedovoljna emotivna stabilnost.

Za razliku od rezultata Heksagon testa (HEX), vrijednosti aritmetičke sredine motoričkog testa padajući štap (REFL) su u zoni većih, te nas one upućuju na zaključak da su odbojkaši bili dosta uspješni u realizaciji postavljenog zadatka, te da su u ovom testu imali potreban nivo koncentacije pažnje bez remetećih faktora, koordinaciju pokreta ruke i brzinu reagovanja.

U prilog ovoj konstataciji pomenućemo istraživanje Vukovića (1996) koji je utvrdio da za odbojkaše postoje statistički značajne razlike u morfološkim karakteristikama, kako u manifestnom (visina tijela, dužina ruke, širina karlice, širina šake, masa tijela, obim potkoljenice, obim podlaktice), tako i u latentnom prostoru (longitudionalna dimenzionalnost skeleta). U strukturi motoričkih sposobnosti su se izdvojile dvije latentne dimenzije: eksplozivna snaga i agilnost.

Faktorska struktura prostora preciznosti odbojkaša

U Tabeli 2, prikazane su vrijednosti koeficijenta diskriminacije (Eigenvalue). Prema vrijednostima koeficijenta diskriminacije (vrijednost > 1) izolovane su četiri glavne komponente, koje objašnjavaju 61,05% zajedničke varijanse (Total Variance %) cijelog sistema za uzorak odbojkaša. Prva komponenta objašnjava 19,64% zajedničke varijanse, druga komponenta objašnjava 15,36% zajedničke varijanse, treća komponenta 14,30%, a četvrta komponenta samo 11,76% zajedničke varijanse. Komunaliteti su prikazani zajedno sa značajnim glavnim komponentama.

U Tabeli 3 prikazana je struktura prostora preciznosti odbojkaša, zapravo, korelacije primijenjenih motoričkih zadataka sa četiri glavne komponente definisane kao faktori istraživanog prostora. Obilježene su faktorske težine koje su veće od 0,304.

Poštujući hijerarhiju izolovanih faktora i stepen objašnjenja ukupne varijanse, prvi faktor (F1) kod odbojkaša definisan je kao preciznost pogađanja cilja "čekićem". Drugi faktor (F2) definisan je kao koordinacija tijela u odbojkaškom terenu. Treći faktor (F3) definisan je kao preciznost pogađanja cilja prstima. I četvrti, zadnji faktor (F4), koji po hijerarhiji objašnjava najmanji

TABLE 2
Factor precision space structures of the male volleyball players.

TABELA 2
Faktorska struktura prostora preciznosti odbojkaša.

Component	Eigenvalue	% Total Variance	Cumulative Eigenvalue	Cumulative %
F1	2.16	19.64	2.16	19.64
F2	1.69	15.36	3.85	35.00
F3	1.57	14.30	5.42	49.30
F4	1.29	11.76	6.72	**61.05**

Legend: **F1** - Precision of shooting a target with "bump" (Preciznost pogađanja cilja "čekićem");
F2 - Body coordination in the volleyball court (Koordinacija tijela u odbojkaškom terenu);
F3 - Precision of shooting a target with fingers (Preciznost pogađanja cilja prstima);
F4 - Motor manipulation with arms and legs (Motorna manipulacija rukama i nogama);
Component - Komponenta; Eigenvalue - Svojstvena vrijednost; % Total Variance - % ukupne varijanse; Cumulative Eigenvalue - Kumulativna svojstvena vrijednost; Cumilative % - Kumulativno %.

TABLE 3
Factor structure of precision of the male volleyball playrs, the main components and communality.

TABELA 3
Faktorska struktura prostora preciznosti odbojkaša, glavne komponente i komunaliteti.

	F1	F2	F3	F4	R^2
SHTF	.09	.03	**.84**	.24	.34
SHTH	**.86**	-.02	.21	-.05	.52
SVTF	.29	-.39	**-.50**	-.34	.28
SVTH	**.59**	.54	.03	-.03	.38
STHP2	**.55**	.30	.15	-.28	.29
SPIKE	-.01	.23	**-.62**	.45	.23
OHJ	**.47**	-.41	-.07	.42	.26
KOONET	-.32	**-.62**	.36	.18	.28
KOOPS	-.35	**.53**	.14	-.08	.30
HEX	-.44	.15	.07	**-.56**	.27
REFL	.21	-.49	.05	**-.55**	.19

Legend: **F1** - Precision of shooting a target with "bump" (Preciznost pogađanja cilja "čekićem");
F2 - Body coordination in the volleyball court (Koordinacija tijela u odbojkaškom terenu);
F3 - Precision of shooting a target with fingers (Preciznost pogađanja cilja prstima);
F4 - Motor manipulation with arms and legs (Motorna manipulacija rukama i nogama);
R² - Multiple R-square (Višestruki R-kvadrat); **SHTF** - Shooting the horizontal target with fingers (Pogađanje horizontalnog cilja prstima); **SHTB** - Shooting the horizontal target with the "bump" (Pogađanje horizontalnog cilja "čekićem"); **SVTF** - Shooting the vertical target with fingers (Pogađanje vertikalnog cilja prstima); **SVTH** - Shooting the vertcal target with "bump" (Pogađanje vertikalnog cilja "čekićem"); **STHP2** - Shooting the target in the horizontal plane from position 2 (Pogađanje horizontalnog cilja u poziciji 2);
SPIKE - Shooting the horizontal target with spike technique (Pogađanje horizontalnog cilja smečiranjem iz skoka); **OHJ** - One-hand juggling a ball through a hoop (Jednoručno žongliranje loptom kroz obruč); **KOONET** - Coordination by the volleyball net (Koordinacija uz mrežu); **KOOSP** - Coordination in the space (Koordinacije u prostoru);
HEX - Hexagon test (Heksagon test); **REFL** - Falling rod (Padajući štap).

fraction of the total variability, is described as a motor manipulation with arms and legs.

According to these data, for the precision factor of shooting a target with "bump" statistically most contribute motor tests shooting the horizontal target with the "bump" (SHTB = -.86), shooting the vertcal target with "bump" (SVTB = -.59) and the shooting the target in the horizontal plane from position (STHP2 = .55). The minimum contribution to this factor has a one-hand juggling a ball through a hoop test (OHJ = .47). The highest contributing tests to the second isolated factor are: test of coordination by the volleyball net (KOONET = -.62) and the test of coordination in the space (KOOSP = -.53).

To the precision factor of shooting the target with fingers contribution comes from the tests shooting the horizontal target with fingers (SHTF = .84) and shooting the horizontal target with spike technique (SPIKE = -.62), while the smallest projection on the second factor has a test shooting the vertical target with fingers (SVTF = -.50) hexagon test (HEX = -.56) and test evaluation of reaction time: a falling rod (REFL = -.55) showed the biggest projection on the motor factor manipulation with arms and legs.

The first factor describes a group of motor tests which are dominated by the precision technique of passing the ball with forearms. This factor determines the tests of: shooting the horizontal target with the "bump", shooting the vertical target with the "bump" and shooting the target in the horizontal plane from position 2. The male volleyball players have shown best results in the test in which they had to have a very precise technique of adding with forearm to a shoot horizontal target. This confirms the mutual correlation.

Motor test of one-hand juggling a ball through a hoop is also a test that determined the precision factor of shooting a target with the "bump". Relationship between the four motor tests can be found in concentrating on the task, good ball handling and good ball control. Coordination factor at the volleyball court was described as a second factor. This factor is determined by two tests: test coordination by the volleyball net and the test coordination in the space. Orientation in space stands out as an important feature of this test given that the task was realized in limited circumstances, namely, in the space with dimensions of a volleyball courts.

The third factor relates to the precision of shooting at a target with fingers. It is determined by these tests: shooting the horizontal target with fingers, shooting the vertical target with fingers and shooting the horizontal target with spike technique. Particularly singled out was the first motor test which compared to other tasks within this factor seems to be the easiest to implement. This confirms the earlier con-

dio ukupnog varijabiliteta, opisan je kao motorna manipulacija rukama i nogama.

Prema navedenim podacima, faktoru preciznosti pogađanja cilja "čekićem" najviše statistički doprinose motorički test pogađanje horizontalnog cilja "čekićem" (SHTB = -0,86) test pogađanje vertikalnog cilja "čekićem" (SVTB = -0,59) i pogađanje vertikalnog cilja u poziciji 2 (STHP2 = -0,55). Najmanji doprinos ovom faktoru ima test jednoručno žongliranje loptom kroz obruč (OHJ = 0,47). Drugom izolovanom faktoru najviše doprinose testovi: koordinacija uz mrežu (KOONET = -0,62) i koordinacija u prostoru (KOOSP = -0,53).

Faktoru preciznosti pogađanja cilja prstima najviše doprinose motorički testovi pogađanje vertikalnog cilja prstima (SHTF = 0,84) i pogađanje horizontalnog cilja smečiranjem iz skoka (SPIKE = -0,62), dok najmanju projekciju na drugi faktor ima pogađanje vertikalnog cilja prstima (SVTF = -0,50). Najveću projekciju na faktor motorne manipulacije rukama i nogama pokazali su testovi Heksagon test (HEX = -0,56) i test procjene vremena reakcije padajući štap (REFL = -0,55).

Prvi faktor opisuje grupu motoričkih testova u kojima također dominira preciznost tehnikom odbijanja lopte podlakticama. Ovaj faktor određuju testovi: pogađanje horizontalnog cilja "čekićem", pogađanje vertikalnog cilja "čekićem" i pogađanje horizontalnog cilja u poziciji 2. Odbojkaši su najbolje rezultate pokazali u testu u kojem su tehnikom odbijanja podlakticama morali što preciznije pogađati horizontalan cilj. To potvrđuje međusobna korelacija.

Motorički test jednoručno žongliranje loptom kroz obruč je također test koji je odredio faktor preciznosti pogađanja cilja "čekićem". Vezu između ova četiri motorička testa možemo tražiti u koncentraciji na zadatak, spretnom baratanju sa loptom i dobroj kontroli lopte. Kao drugi faktor opisan faktor koordinacije u odbojkaškom terenu. Ovaj faktor određuju dva testa: koordinacija uz mrežu i koordinacija u prostoru. Orijentaciju u prostoru ističemo kao važnu karakteristiku ovog testa s obzirom da je zadatak realizovan u ograničenim uslovima, to jeste, na prostoru koji je dimenzija odbojkaškog terena.

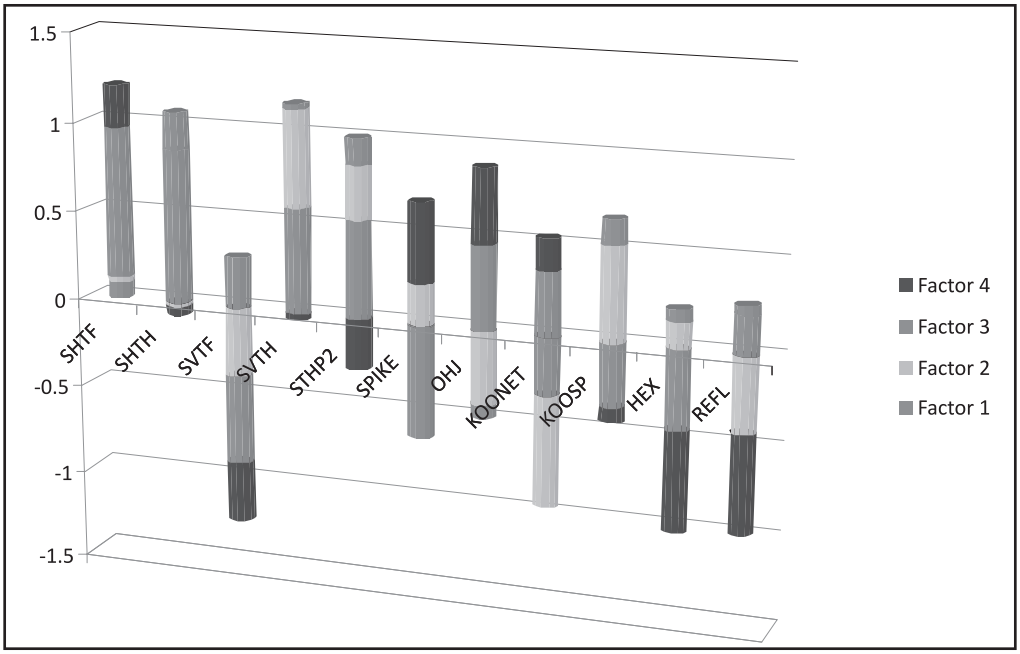
Treći faktor odnosi se na preciznost gađanja cilja prstima. Njega određuju testovi: pogađanje horizontalnog cilja prstima, pogađanje vertikalnog cilja prstima i pogađanje horizontalnog cilja smečiranjem iz skoka. Posebno se izdvojio prvi motorički test koji je u odnosu na ostale zadatke u okviru ovog faktora bio čini se najjednostavniji za realizaciju, što potvrđuje raniju konstataciju da su se lakše rješavali zadaci koji su

FIGURE 2

Graphic presentation of the factor structure of the precision of the male volleyball players.

SLIKA 2

Grafički prikaz faktorske strukture preciznosti odbojkaša.



Legend: **Factor 1** - Precision of shooting a target with "bump" (Preciznost pogađanja cilja "čekićem"); **Factor 2** - Body coordination in the volleyball court (Koordinacija tijela u odbojkaškom terenu); **Factor 3** - Precision of shooting a target with fingers (Preciznost pogađanja cilja prstima); **Factor 4** - Motor manipulation with arms and legs (Motorna manipulacija rukama i nogama); **SHTF** - Shooting the horizontal target with fingers (Pogađanje horizontalnog cilja prstima); **SHTB** - Shooting the horizontal target with the "bump" (Pogađanje horizontalnog cilja "čekićem"); **SVTF** - Shooting the vertical target with fingers (Pogađanje vertikalnog cilja prstima); **SVTH** - Shooting the vertcal target with "bump" (Pogađanje vertikalnog cilja "čekićem"); **STHP2** - Shooting the target in the horizontal plane from position 2 (Pogađanje horizontalnog cilja u poziciji 2); **SPIKE** - Shooting the horizontal target with spike technique (Pogađanje horizontalnog cilja smečiranjem iz skoka); **OHJ** - One-hand juggling a ball through a hoop (Jednoručno žongliranje loptom kroz obruč); **KOONET** - Coordination by the volleyball net (Koordinacija uz mrežu); **KOOSP** - Coordination in the space (Koordinacije u prostoru); **HEX** - Hexagon test (Heksagon test); **REFL** - Falling rod (Padajući štap).

clusion that it is easier to solve problems that have assumed horizontal target shooting and one for the second sample. The connection of motor test shooting the horizontal target with spike technique with this factor can be explained by the ability to control the ball and good accuracy with one or two hands.

The fourth factor in the area of volleyball precision is defined as a factor in motor manipulation of the hands and feet. Manipulation of legs refers to the hexagon test, and manipulation of the hands to the evaluation of reaction time: test a falling rod, in which agility or the ability to quickly change direction in certain space and time dominate, but also a high degree of concentration and nerve-muscle reaction.

podrazumijevali gađanje horizontalnog cilja i za jedan i za drugi uzorak. Veza motoričkog testa pogađanje horizontalnog cilja smečiranjem iz skoka sa ovim faktorom se može objasniti sposobnošću kontrole lopte i dobrom preciznošću sa jednom i dvije ruke.

Četvrti faktor u prostoru preciznosti odbojkaša definisan je kao faktor motorne manipulacije rukama i nogama. Manipulacija nogama odnosi se na Heksagon test, a manipulacija rukama na procjenu vremena reakcije: test padajući štap, u kojima preovladava agilnost ili sposobnost brze promjene pravca u određenom prostoru za određeno vrijeme, ali i visok stepen koncentracije i nervno-mišićne reakcije. Važnu

Motor coordination of the upper and lower extremities, coordination in the rhythm and correct technique each have an important role in the realization of the set of tests.

Fleishman (1954) mostly dealt with factor analysis of the precision and is the most widely tested and has contributed to the knowledge of precision most. He asked for the smallest possible number of capabilities that could explain the motor behavior that requires skillful and precise movements. He found two out of ten isolated factors which could explain the precise movements. One was related to the ability to control arms in the targeting and the author called it "hands" skills. It came out from looking at variables obtained from motor tasks that required the exercise of a series of precisely focused and precise movements. The other factor is the "strength of arms and hands", which was obtained from the task in which a safe hand movement, with the minimum power and minimum speed manifest is to be obtained.

Authors (Gredelj, Metikoš, Hošek, & Momirović, 1975; Kurelić et al., 1975) pointed to precision in an effort to define the entire space of motor skills. The common conclusion on the basis of which precision was appointed as a factor is that it can be called so but only with caution, given the insufficient number of measured motor manifestations that are dependent on motor skills.

CONCLUSION

Based on the results obtained the following was concluded: there are certain manifest dimensions within the research area, defined as a space precision.

Also the structure of motor skills of precision in male volleyball players, the precision factors of shooting targets with the fingers and "bump" in the horizontal and vertical planes are present. It is also confirmed that a factor of coordination in the area of volleyball court and a speed factor of nerve-muscle response are present. We can also conclude that within the structure of technical-tactical elements particular types of precision by male volleyball players operate, that can be defined as precision factors in the technique of adding with the finger, "bump" technique and spike technique. Accordingly, a motor ability of precision can be distinguished as a separate phenomenon and interpreted as a factor in the successfull set of technical - tactical structures of volleyball selected for this research.

When it comes to determining the structure of motor abilities, it is still quite unclear. Previous studies have shown that the problem of their structure only began to be dismissed. In time, with the factorial approach to the study of anthropological space, it is gathered more information to confirm that

ulogu u realizaciji postavljenih motoričkih testova ima i koordinacija gornjih i donjih ekstremiteta, koordinacija u ritmu i korektna tehnika.

Faktorskom analizom preciznosti bavio se Fleishman (1954) i najšire je ispitao i najviše doprinjeo poznavanju preciznosti. Tražio je najmanji mogući broj sposobnosti kojima bi se moglo objasniti motoričko ponašanje za koje su potrebni vješti i precizni pokreti. Od deset izdvojenih faktora našao je dva kojima bi se mogli objasniti precizni pokreti. Jedan se odnosio na sposobnosti kontrolisanja ruke prilikom ciljanja i autor ga je nazvao "vještina ruke". Izdvojen je iz varijabli dobijenih na osnovu motoričkih zadataka koji su zahtijevali vršenje niza tačno usmjerenih i preciznih pokreta. Drugi faktor je "čvrstina ruke i šake" koji je dobijen na osnovu zadataka u kojima se uz minimum snage i brzine ispoljava siguran pokret ruke.

U nastojanju da se definiše cjelokupan prostor motorike, pored ostalih faktora izdvojen je i onaj koji su autori (Gredelj, Metikoš, Hošek i Momirović, 1975; Kurelić i saradnici, 1975) imenovali kao preciznost. Zajednički zaključak na osnovu kojeg je preciznost imenovana kao faktor je da se može nazvati tako, ali samo sa oprezom, s obzirom na nedovoljan broj mjerenih motoričkih manifestacija koje zavise od te motoričke sposobnosti.

ZAKLJUČAK

Na osnovu dobijenih rezultata utvrđeno je i zaključeno sljedeće: da postoje izvjesne manifestne dimenzije unutar posmatranog prostora definisanog kao prostor preciznosti.

Zatim, da u strukturi motoričke sposobnosti preciznosti odbojkaša djeluju faktori preciznosti pogađanja ciljeva prstima i "čekićem" u horizontalnoj i vertikalnoj ravni. Takođe je potvrđeno da djeluju i faktor koordinacije u prostoru odbojkaškog terena i faktor brzine nervno-mišićnog reagovanja. Zaključujemo i to da u strukturi tehničko-taktičkih elemenata djeluju posebni tipovi preciznosti odbojkaši koji se mogu definisati kao faktori preciznosti u tehnici dodavanja prstima, tehnici dodavanja čekićem i tehnici smečiranja. Prema tome, motorička sposobnost preciznost se može izdvojiti kao poseban fenomen i tumačiti kao faktor uspješnosti u postavljenim tehničko-taktičkim strukturama odbojke izabranih za ovo istraživanje.

Kada je u pitanju utvrđivanje strukture motoričkih sposobnosti, još uvijek ima dosta nejasnoća. Dosadašnja istraživanja pokazuju da je problem njihove strukture tek počeo da se razrješava. Faktorskim pristupom u istraživanju ovog antropološkog prostora, vremenom se prikupilo mnogo informacija koje potvrđuju da

there are multiple factors and their minor or major influence which raises a new issues in the structure of motor abilities, especially the question of their mutual relations.

The results are important in the investigation area of motor skills, especially for the further study of the precision skills of male volleyball players. The volleyball coaches will be also able to effectively plan and implement the training program of technical and tactical elements. The knowledge about structure of the precision motor skills of male volleyball players, will allow teachers of physical education a better realization of volleyball program in physical education and sports and recreatives to apply volleyball for recreation and leisure time.

postoji više faktora i njihovih manjih ili većih uticaja čime se otvaraju nova pitanja u strukturi motoričkih sposobnosti, posebno pitanje njihovih međusobnih relacija.

Dobijeni rezultati su značajni za istraživanje prostora motoričkih sposobnosti, a posebno za dalje proučavanje sposobnosti preciznosti odbojkaša. Takođe će i odbojkaški treneri moći efikasnije planirati, programirati i realizovati treniranje tehničko-taktičkih elemanata. Saznanje o strukturi motoričke sposobnosti preciznosti odbojkaša će omogućiti nastavnicima fizičkog vaspitanja bolju realizaciju programa odbojke u nastavi fizičkog vaspitanja, a rekreatorima primjenu odbojke u rekreaciji i slobodnom vremenu.

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DIE STRUKTUR DER ISOLIERTEN FAKTOREN DER PRÄZISION BEI DEN VOLLEYBALLSPIELERN

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Bisherige Erkenntnisse über motorishe Fähigkeiten der Präzision (Strahonja, 1978; Strahonja, Janković und Šnajder, 1982; Janković, 1988; Stoiljković, 2003) umfassten hauptsächlich die Struktur des Spiels bei den Vol-

leyballspielern und Spielerinen, d. h. Die Lösung der motorischen Aufgaben während des Trainigs der bestimmten Situationen im Spiel oder im Volleyballwettbewerb. Es handelt sich, also, nur um einige Teile des Strukturs des Spiels oder es wurden die Faktoren in Betracht gezogen, die direkt oder indirekt für die Struktur Wettbewerbaktivitäten verbunden sind. Im latenten Feld der Motorik sind zwei Modalitäten der Präzision wichtig: die Präzision des Schieβens und die Präzision des Zielens. Für das Volleyball ist karakteristisch die Präzision des Schieβens. Sie kommt im Volleyball als Stukturteil bei allen technisch-taktischen Elementen (der Aufschlag, Smash, Ballheben, der Block, die Serviceaufnahme, die Verteidigung im Feld).

Das Objekt dieser Forschung ist die Präzision als ein Faktor des Erfolges bei den Volleyballspielern. Ein konkretes Problem bezieht sich auf die Realisation dieser motorischen Fähigkeit durch die Teste die klar definiert und die metrisch geprüft sind und die für das Gebiet der technisch-taktischen Struktur des Volleyballs karakteristisch sind. Das Ziel der Forschung ist die Faktorstruktur der motorischen Fähigkeit der Präzision für die Volleyballspieler festzustellen. Die Aufgabe ist die Stufe der Korrelation der angewandten motorischen Teste mit Hauptkomponenten festzustellen die als Faktoren des Forschungsgebiets definieirt sind. Das Modell der Prüflinge waren die Volleyballspieler aus den Sportklubs aus Niš, die 14 bis 16 Jahre alt sind. Es wurde 11 motorische Teste benutzt, für die Einschätzung der folgenden potentiellen Faktoren: die Treffenpräzision des Ziels in horizontaler Position, die Treffenpräzision des Ziels in vertikaler Position, Körperkoordination auf dem Spielplatz, die Präzision der Smashtehnik und nervliche Reaktion und Muskelreaktion.

Die motorischen Teste sind auf diese Weise definiert: das Treffen des horizontalen Ziels mit Fingern (PRHOR), das Treffen des horizontalen Ziels mit "Bagger" (ČEHOR), das Treffen des vertikalen Ziels mit Fingern (PRVER), das Treffen des vertikalen Ziels mit "Bagger" (ČEVER), das Treffen des horizontalen Ziels in der Pozition 2 (ČEPOZ2), das Treffen des horizontalen Ziels durch einen Smashsprung (SMEČ), einhändiges Jonglieren mit dem Ball durch ein Reifen (ŽONG), der Koordinationtest am Netz (KOOMRE), der Koordinationtest im Raum (KOOPRO), der Hexagontest (HEKS) und der Test "der fallende Stab" (REFL).

Um erhaltene Informationen zu bearbeiten, wurden die Methoden der beschreibenden Statistik und der Faktoranalyse benutzt. Um die statistischen Parameter leichter zu interpretieren, wurde die Struktur der motorischen Präzision durch Hotteling Methode der Hauptkomponenten festgestellt. Die Zahl der bedeutenden Hauptkomponenten ist durch Guttmann-Kreiser Kriterien bestimmt.

Die Korrelationanalyse wurde benutz, um die Verbindung der angewandten motorischen Teste mit Hauptkomponenten festzustellen. Diese Hauptkomponenten sind als potentielle Raumfaktoren der Präzision für die Volleyballspieler definiert. Die statistischen Hauptparameter zeigen, dass die Werte der hauptstatistischen Parameter für das Modell der Volleyballspieler in der Grenze der normalen Werte sind. Das ermöglichte weitere statistische Bearbeitung der Angaben in der Analyse der komparativen Statistik aber auch in der Analyse der Faktorstruktur des Präzisionraums der Volleyballspieler. Nach den Werten der Koeffitienten des Unterschieds (der Wert > 1) sind vier Hauptkomponenten isoliert, die 61,05% der gemeinsamen Variance des ganzen Systems für das Modell der Volleyballspieler erklären. Mann hat hier die Korrelation der angewandten motorischen Teste mit Hauptkomponenten bekommen, die als Faktoren des Forschungraums definietr sind.

Wenn wir die Hiearchie der isolierten Faktoren und das Niveau der Erklärung der Gesamtvariance respektieren, dann erfahren wir, dass der erste Faktor (F1) bei den Volleyballspielern als Präzision des Zieltreffens mit "Bagger" definiert ist. Der zweite Faktor (F2) ist als die Koordination des Körpers auf dem Volleyballspielplatz. Der dritte Faktor (F3) ist als Präzision des Zieltreffens mit den Fingern. Der vierBisherige Erkenntnisse über motorishe Fähigkeiten der Präzision (Strahonja, 1978; Strahonja, Janković und Šnajder, 1982; Janković, 1988; Stoiljković, 2003) umfassten hauptsächlich die Struktur des Spiels bei den Volleyballspielern und Spielerinen, d. h. Die Lösung der motorischen Aufgaben während des Trainigs der bestimmten Situationen im Spiel oder im Volleyballwettbewerb. Es handelt sich, also, nur um einige Teile des Strukturs des Spiels oder es wurden die Faktoren in Betracht gezogen, die direkt oder indirekt für die Struktur Wettbewerbaktivitäten verbunden sind. Im latenten Feld der Motorik sind zwei Modalitäten der Präzision wichtig: die Präzision des Schieβens und die Präzision des Zielens. Für das Volleyball ist karakteristisch die Präzision des Schieβens. Sie kommt im Volleyball als Stukturteil bei allen technisch-taktischen Elementen (der Aufschlag, Smash, Ballheben, der Block, die Serviceaufnahme, die Verteidigung im Feld).

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Schlüsselwörter: technisch-taktische Stuktur, die Faktoren, die Präzision, das Volleyballspielll

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EFEKTI SPECIFIČNOG MODELA TRENINGA NA TJELESNU KOMPOZICIJU DŽUDISTA MLAĐEG SENIORSKOG UZRASTA

EFFECTS OF A SPECIFIC MODEL OF TRAINING ON BODY COMPOSITION OF JUDO ATHLETES OF YOUNGER SENIOR AGE

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SUMMARY

The goal of a coach is to prepare an appropriate model of training for their athletes and provide adequate and healthy way of regulating their body weight.

On a sample of 32 judo athletes of younger senior age on the territory of the city of BanjaLuka and municipality of Laktaši, a specific model of training was applied for a period of ten weeks and the judo athletes were divided into two groups. One group was the control group, and other was experimental. The experimental group has implemented 60 training sessions, of which 40 judo trainings (25 technical-tactical and 15 situational judo trainings-randoria) and 20 trainings with the load (50-80% of 1 RM).

In this period, the control group worked only judo trainings or 40 training sessions. Statistical analysis of the results is divided into two segments - the descriptive statistics and application of methods of the inferential statistics. The initial and final measurements of body composition of groups were conducted by the bioelectrical impedance(BIA method), and the two-component(2C) model was used for this work - which divides the whole body in total body fat (*fat mass*) and non-fat body mass (*fat-free mass*). From the field of descriptive statistics on the level of the entire sample, the central and dispersion parameters were calculated. The methods of inferential statistics used in this study were *t*-test for dependent and independent samples and analysis of covariance.

The values of percentage of body fat in the experimental group, which was exposed to a specific training process for a period of ten weeks, were notably statistically reduced during this period.Value of body fat from an initial 23.10% after the training protocol, decreased to 20.41%, on the .01 level of significance. Values of the percentage of body fat in the control group were kept on the same, higher level than recommended for judo, even after the training, pointing to the effects of their less successful training protocol.

Key words: body fat, non-fat body mass, specific training model.

SAŽETAK

Cilj trenera je da svom sportisti pripremi odgovarajući model treninga, te obezbijedi adekvatan i zdrav način regulisanja tjelesne težine.

Na uzorku 32 džudista mlađeg seniorskog uzrasta sa teritorije grada Banja Luka i opštine Laktaši primjenjen je specifični model treninga u trajanju od deset nedjelja, a džudisti su bili podijeljeni u dvije grupe. Jedna grupa je bila kontrolna, a druga eksperimentalna. Eksperimentalna grupa realizovala je 60 treninga, od čega 40 džudo treninga (25 tehničko-taktičkih i 15 situacionih džudo treninga – randorija) i 20 treninga sa opterećenjem (50-80% od 1 RM).

Kontrolna grupa je u navedenom periodu radila samo džudo treninge, odnosno 40 treninga. Statistička obrada dobijenih rezultata je podijeljena u dva segmenta - deskriptivna statistika i primjena metoda inferencijalne statistike. Urađena su inicijalna i finalna mjerenja tjelesnog sastava grupa bioelektričnom impedancom (BIA metodom), a u radu je korišćen dvokomponentni (2C) model - koji cijelo tijelo dijeli na ukupnu tjelesnu mast (*fat mass*) i bezmasnu tjelesnu masu (*fat-free mass*). Iz prostora deskriptivne statistike na nivou čitavog uzorka izračunati su centralni i disperzivni parametri. Od metoda inferencijalne statistike u ovom istraživanju su korišteni *t*-test za zavisne i nezavisne uzorke i analiza kovarijanse.

Vrijednosti procenta tjelesne masti u eksperimentalnoj grupi, koja je bila izložena specifičnom trenažnom procesu u trajanju od deset nedjelja, su statistički značajno smanjene tokom tog perioda. Vrijednost tjelesne masti sa početnih 23,10 %, nakon trenažnog protokola, se smanjila na 20,41%, na nivou značajnosti 0,01. Vrijednosti procenta tjelesne masti u kontrolnoj grupi i nakon treninga su se zadržale na istom, višem, nivou nego što je to preporučeno za džudo, ukazujući na efekte njihovog, manje uspješnog, trenažnog protokola.

Ključne riječi: tjelesna mast, bezmasna tjelesna masa, specifični model treninga.

INTRODUCTION

Judo is an Olympic discipline, widespread throughout the world. Some studies have shown that judo athletes possess an exceptional strength, capacity and flexibility, as well as low body fat (Thomas, Cox, LeGal, Verde, & Smith, 1989). With the advent of modern judo, a skill adopted by majority, and given the different somatic types, it became necessary to divide them into some more homogeneous groups by weight. It was necessary to adopt certain rules of fighting and deploy the competitors by their body weight. At official competitions, judo athletes compete with opponents who have similar weight, and the opponents in accordance with weight categories, which were three at first, then five, and for over twenty years, there have been seven categories. The goal of the division in categories is to ensure fair and equal fight in terms of strength, power and agility (Artioli et al., 2010). It is known that some judo athletes use several harmful and unlawful methods and means to regulate their body weight, ie. speed up weight loss, which would give them precedence over lighter and weaker opponent.

The polls showed that 80% of competitors take part in the process of losing weight. According to these researches, what is most commonly applied in such a low sodium diet, which contributes to weight loss, are severe restrictions on taking liquids and food, use of saunas, heated rooms and exercise in rubber suits (Steen & Brownell, 1990; Tipton & Tcheng, 1970).

Use of diuretics, laxatives, diet pills are the extreme methods that are often mentioned in the literature (Steen & Brownell, 1990). It is always important to stress that these are illegal means and methods in sport. Athletes correct weight several times in the season, so their weight ranges from 5% to 10% of total body weight (Ibid).

Recent research has shown that the incorrect way to lose weight or use of illegal means to regulate body weight, result in poor motor skills and are extremely dangerous to the health of athletes, in some cases even fatal. It has been proven that rapid weight loss negatively affects the health parameters.

In short, it can lead to acute cardiovascular dysfunction (Allen, Smith, & Miller, 1977), immunosuppression (Kowatari et al., 2001), low bone density (Prouteau, Pelle, Collomp, Benhamou, & Courteix, 2010), a disorder of thermoregulation (Oppliger, Case, Horswill, Landry, & Shelter, 1996), cognitive disorders (Choma, Sforzo, & Keller, 1998), negative mood (Degoutte et al., 2006), hormonal disorders

UVOD

Džudo je olimpijska disciplina rasprostranjena širom svijeta. Neke studije pokazale su da džudisti posjeduju izuzetnu snagu, kapacitet i fleksibilnost, kao i nizak nivo tjelesne masnoće (Thomas, Cox, LeGal, Verde i Smith, 1989). Pojavom modernog džudoa, vještine koju je prihvatila većina, a s obzirom na različite somatske tipove, ukazala se potreba da se oni podijele u neke homogenije grupe po tjelesnoj masi. Bilo je potrebno donijeti i određena pravila borbe a takmičare rasporediti po tjelesnoj težini. Na zvaničnim takmičenjima, džudisti se takmiče sa protivnicima koji imaju sličnu tjelesnu težinu, odnosno protivnicima u skladu sa težinskim kategorijama, kojih je prvo bilo tri, pa pet, a već više od dvadeset godina postoji sedam kategorija. Cilj podjele po kategorijama jeste da se obezbijedi fer i ravnopravna borba u smislu snage, moći i okretnosti (Artioli i saradnici, 2010). Poznato je da pojedini džudisti koriste nekoliko štetnih i nedozvoljenih metoda i sredstava kako bi regulisali tjelesnu masu, tj. ubrzali mršavljenje, čime bi dobili prednost nad lakšim i slabijim protivnikom.

Ankete su pokazale da 80% takmičara učestvuje u procesima gubljenja tjelesne težine. Prema ovim istraživanjima, ono što se najčešće primjenjuje u takvom režimu ishrane koji doprinosi smanjenju tjelesne težine su ozbiljne restrikcije uzimanja tečnosti i hrane, korišćenje saune, zagrijavanih prostorija i vježbanja u gumiranim odjelima (Steen i Brownell, 1990; Tipton i Tcheng, 1970).

Korišćenja diuretika, laksativa, dijetalnih pilula su ekstremne metode koje su često navedene u literaturi (Steen i Brownell, 1990). Uvijek je potrebno naglasiti da se radi o nedozvoljenim sredstvima i metodama u sportu. Sportisti koriguju tjelesnu masu nekoliko puta u sezoni, tako da njihova tjelesna težina varira od 5% do 10% od ukupne tjelesne mase (Ibid).

Najnovija istraživanja pokazala su, da nepravilan način skidanja kilograma ili upotreba nedozvoljenih sredstava za regulisanje tjelesne mase, dovode do slabljenja motoričkih sposobnosti, izuzetno su opasna po zdravlje sportista, u nekim slučajevima čak i smrtonosna. Dokazano je da brzo gubljenje težine negativno utiče na zdravstvene parametre.

Ukratko, to može dovesti do akutnih kardiovaskularnih disfunkcija (Allen, Smith i Miller, 1977), imunosupresije (Kowatari i saradnici, 2001), niske gustine kostiju (Prouteau, Pelle, Collomp, Benhamou i Courteix, 2010), poremećaja termoregulacije (Oppliger, Case, Horswill, Landry i Shelter, 1996), kognitivnih poremećaja (Choma, Sforzo i Keller, 1998), negativnog raspoloženja (Degoutte i saradnici, 2006), hormonalnih poremećaja (Roemmich i Sinning, 1997), privremenog rasta

(Roemmich & Sinning, 1997), temporary growth of defects (Ibid), poor nutritional status (Horswill, Park, & Roemmich, 1990), increased risk of injury (Green, Petrou, Fogarty-Hover, & Rolf, 2007), and the risk of eating disorders (Steen & Brownell, 1990; Oppliger, Landry, Foster, & Lambrecht, 1993).

Increased requirements that characterize modern judo, and the latest training practice and physiological achievements, highlight the necessity of creating new models of training programs,with the aim of achieving better athletic performance as well as body composition in judo as one of its parameters.

The lower physiological limit of fat in the structure of body composition in men is about 5%, and for female athletes, this limit is between 12 and 16%. Muscle mass is also higher in athletes and in males can exceed the value of 55%, even 60% of total body mass (Martin, Spenst, Drinkwater, & Clarys, 1990). In addition, the density of non-fat body mass of individuals is higher than in sedentary people, with a higher mineral content and bone density and muscle mass (Heyward, & Stolarczyk, 1996).Therefore, in analyzing the body composition of athletes, it is necessary to use valid and specific protocols for this population.

The aim of this paper is to show whether a good planning and proper management of the training process, may in time lead athletes to have an optimum weight before getting in "shape". Or obtaining information about body composition of judo athletes of younger senior age after application of two different training processes. And it is the weight that suits him as a somatotype for the expression of the highest possible operating capacity.

METHODS

The sample of respondents

The sample consisted of 32 judo athletes from the two Judo Clubs: Judo Club "Rade Ličina" from Banja Luka and Judo Club "Laktaši" from Laktaši. Respondents were asked to complete the following requirements: have at least three years of training process, that they have no organic and somatic disorders, that are younger senior age, and male sex.

Variables

Body composition was assessed by bio-impedance-meter - BIA method. As a result of this measurement, we get a percentage of body fat (FFM) and percentage of non-fat body mass (fat-free mass). Measurement was conducted with the apparatus for assessing body composition "Body Composition

oštećenja (Ibid), siromašnog nutritivnog statusa (Horswill, Park i Roemmich, 1990), povećanog rizika od povreda (Green, Petrou, Fogarty-Hover i Rolf, 2007), kao i rizika od poremećaja u ishrani (Steen i Brownell, 1990; Oppliger, Landry, Foster i Lambrecht, 1993).

Povećani zahtjevi koje karakteriše savremeni džudo, te najnovija trenažna praksa i fiziološka dostignuća, ističu neophodnost kreiranja novih modela trenažnih programa, sa ciljem ostvarivanja boljih sportskih rezultata pa tako i tjelesne kompozicije u džudou kao jednog od njegovih parametara.

Donja fiziološka granica masti u strukturi sastava tijela kod muškaraca iznosi oko 5%, a kod žena sportistkinja između 12 i 16% masti. Mišićna masa takođe je veća kod sportista i kod muškaraca može prijeći vrijednosti od 55%, pa i 60% ukupne mase tijela (Martin, Spenst, Drinkwater i Clarys, 1990). Pored toga, gustina bezmasne tjelesne mase pojedinaca je veća nego kod sedentarnih osoba, sa većim sadržajem minerala, i koštanom gustinom i mišićnom masom (Heyward i Stolarczyk, 1996). Upravo zbog toga, pri analiziranju tjelesne kompozicije sportista potrebno je koristiti validne i specifične protokole za ovu populaciju.

Cilj ovog rada je da se prikaže, da li se dobrim planiranjem i pravilnim upravljanjem trenažnog procesa, sportista može na vrijeme dovesti da pred ulazak u "formu" ima optimalnu tjelesnu težinu, odnosno dobijanje podataka o tjelesnoj kompoziciji džudista mlađeg seniorskog uzrasta nakon primjene dva različita trenažna procesa. To je ona tjelesna težina koja mu odgovara kao somatotipu za iskazivanje najveće moguće radne sposobnosti.

METODE

Uzorak ispitanika

Uzorak su činila 32 džudista iz dva džudo kluba: Džudo klub "Rade Ličina" iz Banje Luke i Džudo klub "Laktaši" iz Laktaša. Ispitanici su ispunjavali sljedeće uslove: da imaju najmanje tri godine trenažnog procesa, da nemaju organskih i somatskih oboljenja, da su mlađeg seniorskog uzrasta, i da su muškog pola.

Varijable

Tjelesna kompozicija je procijenjivana bioimpedancometrijskom - BIA metodom. Kao rezultat mjerenja dobili smo procenat tjelesne masti (FFM) i procenat bezmasne tjelesne mase (fat-free mass). Mjerenje je rađeno aparatom za procjenu tjelesne kompozicije "Body Composition Analyzer Jawon Gaia

Analyzer 357 Jawon Gaia" (Jawon Medical, South Korea), and in addition to a percentage of body fat (FFM) and percentage of non-fat body mass (fat-free mass), we determined the following parameters: body weight, body height, standard weight, body fat index.

Description of specific models of training

The specific program is implemented for 10 weeks. It consisted of 25 technical - tactical, 15 situational--specific and 20 trainings with the load, i.e. 12 hours of exercise per week. Additional training with the load was carried out twice a week at the gym, and the method that has dominated in exercising is lifting the submaximal load at maximum speed. The load ranged from 50% to 80% of the maximum, number of sets 4-6, 4-6 repetitions, resting between repetitions per set for 2-3 minutes and 4-5 minutes between exercises.

357", (Jawon Medical, South Korea), a pored procenta tjelesne masti (FFM) i procenta bezmasne tjelesne mase (fat-free mass), određivali smo i sledeće parametre: tjelesnu težinu, tjelesnu visinu, standardnu težinu, bodi masni indeks.

Opis specifičnog modela treninga

Specifični program je realizovan u trajanju od 10 sedmica. Sastojao se od 25 tehničko - taktičkih, 15 specifično-situacionih i 20 treninga sa opterećenjem, odnosno 12 časova vježbanja nedjeljno. Dodatni trening sa opterećenjem realizovan je dva puta sedmično u teretani, a metoda koja je dominirala u vježbanju je podizanje submaksimalnog tereta maksimalnom brzinom. Opterećenje se kretalo u rasponu od 50% do 80 % od maksimuma, broj serija 4-6, broj vježbi 4-6, odmor između ponavljanja u seriji 2-3 minuta, a između vježbi 4-5 minuta.

TABLE 1
Descriptive statistics of the experimental group.

TABELA 1
Deskriptivna statistika eksperimentalne grupe.

Parameter	*n*	*M*	*SD*	*MIN*	*MAX*
Age (years)	16	19.87	2.09	18.00	23.00
Sports experience (years)	16	7.62	4.19	4.00	15.00
Body height (cm)	16	179.25	5.75	170.00	192.00
Body weight (kg)	16	70.99	12.55	54.20	104.20
Fat percentage (%)	16	25.00	5.66	9.40	31.10
Percentage of non-fat mass (%)	16	55.50	7.17	45.90	72.50

Legend: ***n*** - Number of respondents (Broj ispitanika); ***M*** - Sample mena (Aritmetička sredina); ***SD*** - Standard deviation (Standardna devijacija); ***MIN*** - Minimum value (Najmanja vrijednost); ***MAX*** - Maximum value (Najveća vrijednost); Age - Uzrast; Sport experience - Sportski staž; Body height (cm) - Tjelesna visina (cm); Body weight (kg) - Tjelesna težina (kg); Fat percentage (%) - Procenat masti (%); Percentage of non-fat mass (%) - Procenat bezmasne mase (%).

Statistical analysis

Statistical analysis of the results is divided into two segments - descriptive statistics and the application of methods of inferential statistics. As per the area of descriptive statistics, the central and dispersion parameters have been calculated on the entire sample level: arithmetic mean (*M*), standard deviation (*SD*), variation width (*MAX - MIN*), variance (Var), standard error of mean (*SE*). Normality of distribution was tested using the results of D'Agostino-Pearson test. The methods of inferential statistics in this study used *t* - test for dependent and independent samples and analysis of covariance.

Statistička analiza

Statistička obrada dobijenih rezultata je podijeljena u dva segmenta - deskriptivna statistika i primjena metoda inferencijalne statistike. Iz prostora deskriptivne statistike na nivou čitavog uzorka izračunati su centralni i disperzivni parametri: aritmetička sredina (*M*), standardna devijacija (*SD*), varijaciona širina (*MAX – MIN*), varijansa (Var), standardna greška srednje vrijednosti (*SE*). Normalnost distribucije rezultata testirana je primjenom D'Agostino-Pirsonovog testa. Od metoda inferencijalne statistike u ovom istraživanju su korišteni *t* - test za zavisne i nezavisne uzorke i analiza kovarijanse.

RESULTS

The main parameters that reflect the characteristics of both groups are: age, sports experience, body height, body mass, body fat percentage and non-fat mass.

Tables 1 and 2, show the values of parameters that reflect the basic characteristics of both groups.

REZULTATI

Osnovni parametri koji oslikavaju karakteristike obe grupe su: uzrast, sportski staž, tjelesna visina, tjelesna masa, procenat masti i procenat bezmasne mase.

U Tabelama 1 i 2 prikazane su vrijednosti parametara koji oslikavaju osnovne karakteritike obe grupe.

TABLE 2
Descriptive statistics of the control group.

TABELA 2
Deskriptivna statistika kontrolne grupe.

Parameter	*n*	*M*	*SD*	*MIN*	*MAX*
Age (years)	16	19.81	1.72	18.00	23.00
Sports experience (years)	16	6.18	2.04	4.00	11.00
Body height (cm)	16	179.33	5.25	170.00	189.00
Body weight (kg)	16	68.00	14.19	53.30	118.30
Fat percentage (%)	16	21.50	4.13	7.50	24.60
Percentage of non-fat mass (%)	16	65.00	7.00	46.10	72.90

Legend: ***n*** - Number of respondents (Broj ispitanika); ***M*** - Sample mena (Aritmetička sredina); ***SD*** - Standard deviation (Standardna devijacija); ***MIN*** - Minimum value (Najmanja vrijednost); ***MAX*** - Maximum value (Najveća vrijednost); Age – Uzrast; Sport experience – Sportski staž; Body height (cm) – Tjelesna visina (cm); Body weight (kg) – Tjelesna težina (kg); Fat percentage (%) - Procenat masti (%); Percentage of non-fat mass (%) – Procenat bezmasne mase (%).

The percentage of body fat

The following tables (3rd, 4th, 5th, 6th) present the results of changes in body composition under the influence of specific training. It is important to note that at the beginning, in each group of samples, the athletes who had initially lower percentage of body fat (below 15%) were left out of the group. It was unrealistic to expect that their body composition would change with the loss of already low percentage of body fat. For this reason, the number of respondents for this parameter (*n*) was decreased from 16 to 13 in the experimental and to 14 in the control group (Table 3).

The values of body fat percentage in the control group on the initial measurements were less than in the experimental group. Even after the training, they were kept at the same, higher level, than is recommended for the sport, pointing out the effects of their less successful training protocol (Table 5).

Non-fat body mass

Fat-free mass in sport is synonymous with the muscle mass. Its increase with the training protocol

Procenat tjelesne masti

U narednim tabelama (3, 4, 5, 6), predstavljamo rezultate promjene tjelesne kompozicije pod uticajem specifičnog treninga. Važno je napomenuti da su na početku u obje grupe iz uzorka izostavljeni sportisti koji su imali početno niži procenat tjelesne masti (ispod 15%). Bilo je nerealno očekivati da će se njihova tjelesna kompozicija mijenjati gubitkom ionako niskog procenta masti. Tako je broj ispitanika za ovaj parametar (*n*) smanjen sa 16 na 13 u eksperimentalnoj, a na 14 u kontrolnoj grupi (Tabela 3).

Vrijednosti procenta tjelesne masti u kontrolnoj grupi na početnom mjerenju su bile manje nego u eksperimentalnoj grupi. I nakon treninga su se zadržale na istom, višem nivou nego što je to preporučeno za sport, ukazujući na efekte njihovog, manje uspješnog, trenažnog protokola (Tabela 5).

Bezmasna masa

Bezmasna masa u sportu je sinonim za mišićnu masu. Njeno povećanje trenažnim protokolom ukazuje

indicates what is the most important, an increase of a muscle mass. However, in this study, neither group achieved a statistically significant increase in non-fat mass, i.e. muscle mass. This fact is not surprising since it has been many times proven that the muscle hypertrophy occurs only after 8-10 weeks from the beginning of training with the load. Our protocol, neither by its loads nor by its duration, was focused on the development of muscle hypertrophy.

i na ono najbitnije, povećanje mišićne mase. Međutim, u ovom istraživanju nijedna grupa nije ostvarila statistički značajno povećanje bezmasne mase, odnosno mišićne mase. Činjenica ne iznenađuje pošto je mnogo puta dokazano da se hipertrofija mišića javlja tek za 8-10 nedjelja treninga sa opterećenjem. Naš protokol niti je po opterećenjima, niti dužini trajanja bio usmjeren na razvoj hipertrofije mišića.

TABLE 3

Frequencies of the fat percentage per groups.

TABELA 3

Frekvencije procenta masti po grupama.

The experimental group	*n*	The control group	*n*
9.4	1	**7.5**	1
13.9	1	**14.4**	1
14.5	1	15.2	1
17.4	1	15.3	1
18.9	2	15.9	1
19.4	1	16.8	1
20.1	1	16.9	1
22.7	1	17.5	1
22.8	1	17.9	1
24.1	1	19.0	2
25.0	1	19.6	1
26.4	1	20.3	1
26.7	1	20.5	1
26.8	1	24.0	1
31.1	1	24.6	1
In total	16	In total	16

Legend: ***n*** - Number of respondents (Broj ispitanika); The experimental group - Eksperimentalna grupa; The control group - Kontrolna grupa; In total - Ukupno.

TABLE 4

Values of the percentage of body fat in experimental group (%).

TABELA 4

Vrijednosti procenta tjelesne masti u eksperimentalalnoj grupi (%).

The experimental group	*n*	*M*	*SD*	*SE*
Initial	13	23.10**	4.05	1.12
Final	13	20.41	3.20	.88

$p < .002$

Legend: ***n*** - Number of respondents (Broj ispitanika); ***M*** - Sample mena (Aritmetička sredina); ***SD*** - Standard deviation (Standardna devijacija); ***SE*** - Standard error (Standardna greška); The experimental group - Eksperimentalna grupa; Initial - Inicijalno; Final - Finalno; ***p*** - Probability (Vjerovatnoća).

TABLE 5
Values of the percentage of body fat in control group (%).

TABELA 5
Vrijednosti procenta tjelesne masti u kontrolnoj grupi (%).

The control group	*n*	*M*	*SD*	*SE*
Initial	14	18.73	3.03	.84
Final	14	19.22	2.90	.80

$p < .170$

Legend: ***n*** - Number of respondents (Broj ispitanika); ***M*** - Sample mena (Aritmetička sredina); ***SD*** - Standard deviation (Standardna devijacija); ***SE*** - Standard error (Standardna greška); The control group - Kontrolna grupa; Initial - Inicijalno; Final - Finalno; ***p*** - Probability (Vjerovatnoća).

TABLE 6
Covariance, the percentage of fat free mass between groups, final measurements.

TABELA 6
Kovarijansa, procenat bezmasnog tkiva između grupa, završno mjerenje.

Group	*n*	*M*	*SD*
Experimental	16	60.05	7.12
Control	16	58.15	6.68

$p < .258$

Legend: ***n*** - Number of respondents (Broj ispitanika); ***M*** - Sample mena (Aritmetička sredina); ***SD*** - Standard deviation (Standardna devijacija); Experimental - Eksperimentalna; Control - Kontrolna; ***p*** - Probability (Vjerovatnoća).

DISCUSSION

For each sport, in terms of morphological characteristics (body constitution) of athletes, there is an exact percentage of muscle, fat and bone tissues that are the basis for good functional status of the organism, or for top athletic condition.

Analysis of body composition in this study was performed by using a *bioelectrical impedance* (BIA), which is a new, rapid, noninvasive, accurate and comfortable method for the respondents, which has recently gained the trust of experts around the world (Ponorac, 2008). *A two-component model*, which divides the whole body into total body fat (*fat mass*) and non-fat body mass (fat-free mass) was used for this work.

Radovanović, Bratić, Nurkić, and Vukajlović (2005) investigated the impact of targeted training programs prepared on the parameters of anaerobic and aerobic capacity in young judo players with significant experience in training and competition. The results showed statistically important higher levels of anaerobic power (relative value of the average power) and VO_2max,

DISKUSIJA

Za svaki sport, u okviru morfoloških karakteristika (tjelesne konstitucije) sportista, postoje tačno određeni procenti mišićnog, masnog i koštanog tkiva koji su osnova za dobar funkcionalni status organizma, odnosno za vrhunsku sportsku kondiciju.

Analiza tjelesne kompozicije u ovom istraživanju izvršena je upotrebom *bioelektrične impedance* (BIA) koja je nova, brza, neinvazivna, precizna i za ispitanika ugodna metoda, koja je u proteklom periodu zadobila povjerenje stručnjaka širom svijeta (Ponorac, 2008). U radu je korišten *dvokomponentni model*, koji cijelo tijelo dijeli na ukupnu tjelesnu mast (*fat mass*) i bezmasnu tjelesnu masu (fat-free mass).

Radovanović, Bratić, Nurkić i Vukajlović (2005) istraživali su uticaj ciljano pripremljenog treningprograma na parametre anaerobnog i aerobnog kapaciteta kod mladih džudista sa značajnim trenažnim i takmičarskim iskustvom. Analiza dobijenih rezultata pokazala je statistički značajno veće vrijednosti anaerobnog kapaciteta (relativne vrijednosti prosječne

with the decrease in body weight and body fat percentage.

The results of research conducted by Bratić, Radovanović, and Nurkić (2008) with the aim to determine and compare the functional characteristics of the best young judo cadets (n = 11, age 15.7 years ± .5) and younger senior age (n = 8, age 20 years ± 1.2), showed that judo athletes of younger senior age are characterized by lower percentage of body fat and improved aerobic capacity compared to judo cadets.

Looking at the values of the body fat percentage in the experimental group exposed to a specific training process for a period of ten weeks, we see that the average values of body fat significantly decreased during this period. That is, the value of body fat from an initial 23.10% after the training protocol, decreased to 20.41%, on the level of significance of .01. However, despite a reduction in the value of fat percentage, body composition of the experimental group was still in the acceptable upper limits of the sport. Nevertheless, the visibility of the success of specific training is clear with the recommendation to continue to achieve the desired percentage of fat.

Regarding the values of body fat percentage for the control group, after their training protocols, there was no statistically significant change in body fat percentage. Values are from an initial 19.72% slightly reduced to 19.25%. Even after the training, they were kept at the same, higher level, than is recommended for the judo, pointing out the effects of their less successful training protocol.

The study conducted by Silva, Fields, Heymsfield, and Sardinha (2010) on the connection between anaerobic power and body composition of successful judo athletes during the period of three months, which included 10 Korean judo team members, 26 senior members of university teams and 28 junior members of the university team, showed very high correlation of the fat mass and anaerobic power in elite judo athletes, i.e. national team members.

The results show that the judo team members have a higher percentage of muscle and a smaller percentage of fatty component compared to the other two categories of athletes. These results confirm the positive directions of our programmed training model that contributed to the reduction of fatty component.

Also interesting study was conducted by Kim, Cho, Jung, and Yoon (2011) for analyzing the correlation of the body composition and upper body strength in judo athletes. Twenty-seven top judo athletes were measured at the beginning and end of the study, with the time difference of approximately one month. Body composition was estimated by the DXA method,

snage) i VO_2max, uz smanjenje tjelesne težine i procenta masnog tkiva.

Rezultati istraživanja koje su sproveli Bratić, Radovanović i Nurkić (2008) s ciljem utvrđivanja i poređenja funkcionalnih karakteristika najboljih mladih džudista kadetskog (n = 11, uzrast 15,7 godina ± 0,5) i mlađeg seniorskog uzrasta (n = 8, uzrast 20 godina ± 1,2), pokazali su da džudiste mlađeg seniorskog uzrasta karakteriše niži procenat masnog tkiva i bolje aerobne sposobnosti u odnosu na džudiste kadetskog uzrasta.

Posmatrajući vrijednosti procenta tjelesne masti u eksperimentalnoj grupi, koja je bila izložena specifičnom trenažnom procesu u trajanju od deset nedjelja, vidimo da su prosječne vrijednosti tjelesne masti statistički značajno smanjene tokom tog perioda. Odnosno, vrijednost tjelesne masti sa početnih 23,10 %, nakon trenažnog protokola, se smanjila na 20,41%, na nivou značajnosti 0,01. Međutim, uprkos smanjenju vrijednosti procenta masti, tjelesna kompozicija eksperimentalne grupe je još uvijek na gornjim granicama prihvatljivim u sportu. Bez obzira na to, vidljivost uspješnosti specifičnog treninga je jasna sa preporukom da se nastavi do postizanja željenog procenta masti.

Vrijednosti procenta tjelesne masti za kontrolnu grupi, nakon njihovog trenažnog protokola, nije došlo do statistički značajne promjene procenta tjelesne masti. Vrijednosti su sa početnih 19,72 % neznatno smanjene na 19,25%. I nakon treninga su se zadržale na istom, višem, nivou nego što je to preporučeno za džudo, ukazujući na efekte njihovog, manje uspješnog, trenažnog protokola.

Studiju koju su sproveli Silva, Fields, Heymsfield i Sardinha (2010) o povezanosti anaerobne snage i tjelesne kompozicije uspješnih džudista, tokom tri mjeseca, koja je obuhvatila 10 korejskih džudo reprezentativaca, 26 seniora članova univerzitetskog tima i 28 juniora članova univerzitetskog tima, pokazala je veoma veliku povezanost masne komponente i anaerobne snage kod vrhunskih džudista, odnosno reprezentativaca.

Rezultati pokazuju da džudo reprezentativci imaju veći procenat mišićne, odnosno manji procenat masne komponente u odnosu na druge dvije kategorije sportista. Ovi rezultati potvrđuju pozitivne smjernice našeg programiranog modela treninga koji je doprinio smanjenju masne komponente.

Takođe zanimljivu studiju su sproveli Kim, Cho, Jung i Yoon (2011) radi analize odnosa kompozicije tijela i snage gornjeg dijela tijela kod džudista. Dvadesetsedam vrhunskih džudista mjereni su na početku i na kraju studije, sa vremenskom razlikom otprilike jednog mjeseca. Sastav tijela procijenjen je DXA–om metodom, a spektar snage opterećenja

and the range of power load was used to assess the output of the upper body in the bench press position.

The results show that, although not significant, changes were found in body composition and upper body strength. Individual variability was high. Among all the changes in body composition, only total body water and intercellular water were related to variations in the upper body. These results indicate the need for monitoring of total body water, particularly the intercellular water in top judo athletes, in order to avoid a reduction in upper body strength when it reached the desired body weight prior to competition.

All this supports the fact that athletes must take into account the weight loss before an important competition, especially to respect the instructions of the National Sports Athletics Association (NSAA), and to avoid extreme ways of regulating categories, primarily by reducing fluid intake, which contributes to reducing motor abilities of athletes and the endangerment of the health of athletes (Ibid).

Fat-free mass in sport is synonymous with muscle mass. Its increase by the training protocol indicates what is the most important and that is increasing of a muscle mass. However, in our study neither group achieved a statistically significant increase in non-fat or muscle mass. This is not surprising since it is many times the proven fact that muscle hypertrophy occurs only after 8-10 weeks from training with the load. This certainly leaves the possibility of changes in training modalities to achieve muscle hypertrophy as an adaptive change.

Based on the results of programmed training model, and similar results obtained by Radovanovic et al. (2005), we see that especially planned training program contributes to the improvement of body composition of athletes, or reduction of body weight and body fat percentage. Therefore, we can conclude that changes in the plan and ten-week-training- program right before a competition can result in significant changes, even with competitors who have more years in the training process. This confirms the compliance of our training model with the recommendations of previous researches.

CONCLUSIONS

The method of specific sports training model used in the experimental study group experienced a statistically significant decrease in body fat percentage compared to the initial measurement. However, there was no statistically significant reduction in body fat of the control group at the final measurement. Likewise, neither group achieved a statistically significant increase in non-fat, ie, muscle mass. This would

korišćen je za procjenu izlazne snage gornjeg dijela tijela u bench press poziciji.

Rezultati pokazuju da, iako nisu značajne, promjene su pronađene u kompoziciji tijela i snazi gornjeg dijela tijela. Pojedinačna varijabilnost je bila velika. Među svim promjenama kompozicija tijela, samo voda cijelog tijela i interćelijska voda bili su u vezi sa varijacijama gornjeg dijela tijela. Ovi rezultati ukazuju na potrebu za praćenje ukupne vode u tijelu, posebno interćelijske vrhunskih džudo sportista, kako bi se izbjeglo smanjenje snage gornjeg dijela tijela kada je dostignuta željena tjelesna težina prije takmičenja.

Sve ovo nam govori u prilog tome da sportisti moraju da vode računa o skidanju kilograma pred važna takmičenja, prije svega da poštuju uputstva Nacionalnog sportsko atletskog udruženja (NCAA), te da izbjegavaju ekstremne načine regulisanja kategorije, prije svega smanjenjem unosa tečnosti, koje doprinosi smanjenju motoričkih sposobnosti sportiste i ugožavanju zdravlja sportista (Ibid).

Bezmasna masa u sportu je sinonim za mišićnu masu. Njeno povećanje trenažnim protokolom ukazuje i na ono najbitnije, povećanje mišićne mase. Međutim, u našem istraživanju nijedna grupa nije ostvarila statistički značajno povećanje bezmasne, odnosno mišićne mase. Ovo ne iznenađuje pošto je mnogo puta dokazana činjenica da se hipertrofija mišića javlja tek nakon 8–10 nedjelja treninga sa opterećenjem. Ovo svakako ostavlja mogućnost u izmjenama trenažnog modaliteta u svrhu postizanja hipertrofije mišića kao jedne od adaptacionih promjena.

Na osnovu dobijenih rezultata programiranog modela treninga, te sličnih rezultata do kojih su došli Radovanović i saradnici (2005), uočavamo da posebno planinarni trening program doprinosi unapređenju tjelesne kompozicije sportista, odnosno umanjenju tjelesne težine i procenta masnog tkiva. Stoga, možemo zaključiti da izmjene u planu i programu desetonedjeljnog treninga pred samo takmičenje mogu rezultirati značajnim promjenama čak i kod takmičara koji su više godina u trenažnom procesu. Ovo potvrđuje usklađenost našeg modela treninga sa preporukama prethodnih istraživanja.

ZAKLJUČCI

Metodom specifičnog modela sportskog treninga korištenog u istraživanju u eksperimentalnoj grupi došlo je do statistički značajnog smanjenja procenta tjelesne masti u odnosu na početno mjerenje. Međutim, nije došlo do statistički značajnih smanjenja tjelesne masti kontrolne grupe na završnom mjerenju. Isto tako, nijedna grupa nije ostvarila statistički značajno povećanje bezmasne, odnosno, mišićne mase. Ovo bi

certainly be achieved by extending the training protocol and individual selection of loads to induce hypertrophy.

se svakako postiglo produžavanjem trenažnog protokola i individualnim izborom opterećenja u svrhu izazivanja hipertrofije.

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EFFEKTE EINES SPEZIFISCHEN TRAINIGSMODELLS AUF DIE KÖRPERKOMPOSITION JÜNGERER JUDO-SENIOREN

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Die olympische Disziplin Judo ist weltweit verbreitet. Einige Studien haben ergeben, dass Judokas enorme Körperkraft, Kapazität und Flexibilität besitzen, sowie niedriges Körperfettniveau. Im Hinblick auf verschiedene somatische Konstitutionstypen hat man im modernen von der Mehrheit akzeptierten Judo auf die Notwendigkeit hingewiesen, diese in bezüglich der Körpermasse homogene Gruppen einzuteilen. Neue Kampfregeln mussten eingeführt und Wettkämpfer nach ihrem Körpergewicht eingeteilt werden. Bei offiziellen Wettkämpfen treten Judokas gegen Gegner mit ähnlichem Körpergewicht an, d. h. den Gewichtsklassen gemäß, von denen es von den anfänglichen drei, später fünf, heute schließlich schon seit mehr als zwanzig Jahren sieben Klassen gibt. Das Ziel dieser Einteilung ist das Ermöglichen eines fairen und gleichberechtigten Kamfes hinsichtlich der Kraft, Leistungsfähigkeit und der Geschicklichkeit. Es ist allerdings bekannt, dass sich einige Judokas unerlaubter und schädlicher Mittel und Methoden bedienen, um das Körpergewicht zu regulieren, bzw. die Gewichtsabnahme zu beschleunigen, womit sie sich einen Vorteil über leichtere und schwächere Gegner verschaffen.

Anhand einer Stichprobe von 32 jüngeren Judo-Senioren innerhalb des Stadtgebiets Banja Luka und der Gemeinde Laktaši wurde ein spezifisches Trainigsmodell in Dauer von zehn Wochen durchgeführt, wobei die Judokas in zwei Gruppen eingeteilt wurden. Eine Gruppe stellte die Kontrollgruppe dar, während die andere die experimentelle war. Die Probanten mussten folgende Bedingungen erfüllen: ein mindestens dreijähriger Trainigsprozess, das Fehlen jeglicher organischer und somatischer Erkrankungen, jüngeres Seniorenalter und männliches Geschlecht. Die experimentelle Gruppe hat 60 Trainigs realisiert, davon waren 40 Judo-Trainigs (25 technisch-taktische und 15 Situationstrainigs – Randori) und 20 Belastungstrainigs (50-80% des 1RM). Die Kontrollgruppe hat im selben Zeitraum nur Judo-Trainings gemacht, d. h. 40 Trainigs insgesamt. Die statistische Datenbearbeitung wurde in zwei Segmente aufgeteilt – deskriptive Statistik und Methoden der inferenziellen Statistik. Es wurden Initial- und Finalmessungen des Körper-

baus der oben erwähnten Gruppen mit der bioelektrischen Impendanzanalyse vorgenommen (BIA), ferner wurde in der Arbeit das Zweikomponentenmodell (2C) angewendet, das den Körper in die Körperfettmasse (fat mass) und die fettfreie Masse (fat-free mass) gliedert. Die Messungen wurden mit dem „Body Composition Analyzer Jawon Gaia 357“ durchgeführt, ein Gerät für Bestimmung der Körperkomposition, (Jawon Medical, South Korea), zum anderen wurden neben dem prozentuellen Anteil an Körperfettmasse (fat mass) und dem Anteil der fettfreien Masse (fat - free mass) folgende Parameter bestimmt: Körpergewicht, Körpergröße, Standardgewicht, Körperfettindex. Im Bereich der deskriptiven Statistik wurden im Rahmen der gesamten Stichprobe zentrale und dispersive Parameter berechnet. Von den Methoden der inferenziellen Statistik wurden zum Zweck dieser Untersuchung der T-Test für abhängige und unabhängige Stichproben und die Kovarianz--Analyse angewendet.

Der Wert des Körperfettanteils in der experimentellen Gruppe, die dem spezifischen Trainigsprozess zehn Wochen ausgesetzt war, wurde innerhalb dieses Zeitraums statistisch erheblich gesenkt. Der Wert des Körperfetts wurde nach dem Trainingsprotokoll von den anfänglichen 23,10% auf 20,41% gesenkt, auf dem Signifikanz-Niveau von 0,01%. Der Wert des Körperfettanteils in der Kontrollgruppe ist auch nach dem Trainig auf dem gleichen, für Judo jedoch höheren als es zu empfehlen ist, Niveau geblieben, womit auf die Effekte des weniger erflogreichen Trainigsprotokolls gedeutet wird. Zugleich hat keine von den Gruppen eine statistisch bedeutendere Zunahme der fettfreien Masse, bzw. der Muskulatur erreicht. Das könnte aber durchaus durch die Fortsetzung des Trainingsprotokolls und eine individuelle Belastungsauswahl erzielt werden mit dem Ziel des Herbeirufens der Hypertrophie.

Schlüsselwörter: Körperfett, fettfreie Masse, spezifisches Trainingsmodell

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PROGRAM EFIKASNOG ŠUTIRANJA MLADIH KOŠARKAŠA

EFFICIENCY SHOOTING PROGRAM FOR YOUTH BASKETBALL PLAYERS

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SUMMARY

Shooting practice in youth basketball is "cornerstone" for proper shooting technique, likely, enabling the player to get high shooting percentage in a Professional League (adults). The purpose of this study was to verify the efficiency of the shooting fundamental program (n = 18, age 9.85 ± .53). Experimental groups were used in these results. The results showed the effect of shooting fundamental program. Shooting test the lay-ups after this period of an experiment was increased by +1.83 successful attempts in comparison with the result in the control time (+1.45) ($p < .01$). These findings show that efficiency of basketball shooting fundamental program increase shooting percentage during the period of an experiment.

Key words: youth, training process, fundamental skills, fundamentals of shooting, shooting percentage.

SAŽETAK

Šuterski trening kod mladih košarkaša je "kamen temeljac" za pravilnu tehniku šutiranja i, po svoj prilici, omogućava igraču da postigne visok šuterski postotak u profesionalnoj ligi (odrasli). Cilj ovog istraživanja bio je da provjeri efikasnost fundamentalnog programa šutiranja (n = 18, starosti 9,85 ± 0,53). Za rezultate je korišćena eksperimentalna grupa. Rezultati su pokazali efektan program fundamentalnog šutiranja. Test šutiranja polaganjem, nakon ovog eksperimentalnog perioda, porastao je na +1,83 uspješna pokušaja u odnosu na rezultate u kontrolnom periodu (+1,45) ($p < 0,01$). Ovi rezultati pokazuju da efikasnost fundamentalnog programa šutiranja u košarci povećava procenat šuta tokom eksperimentalnog perioda

Ključne riječi: mladi, proces treninga, fundamentalne vještine, fundamenti šutiranja, procenat šuta.

INTRODUCTION

Basketball experts and fans consider shooting the best known fundamental skills in basketball (Krause, Meyer, & Meyer, 2008). Shooting practice is very important part of practice session at any level of performance, from beginners to professional players. At the beginners' level, basic fundamental skills should be learned, including basics of shooting fundamentals which will be improved in later stages of development.

The elementary school level is from 7 to 10 years old. Children are sensitive for developing their coordination skills, speed and agility during this period of life .Their movements are very efficient and accurate (Kasa, 2006). According to ibidem this period is called "the first time learning effect". Young players of this age are able to learn new movements faster with greater effectiveness. It is necessary to focus on specialized training, more than on general preparation (Figure 1).

UVOD

Košarkaški stručnjaci i ljubitelji ove igre smatraju da je šutiranje najprepoznatljivija fundamentalna vještina u košarci (Krause, Meyer i Meyer, 2008). Šuterski trening je vrlo važan dio treniranja na bilo kom nivou igranja košarke, od početnika do profesionalnih igrača. Na nivou početnika, osnovne fundamentalne vještine treba učiti uključujući i osnove šutiranja koje će biti poboljšavane u kasnijim fazama razvoja.

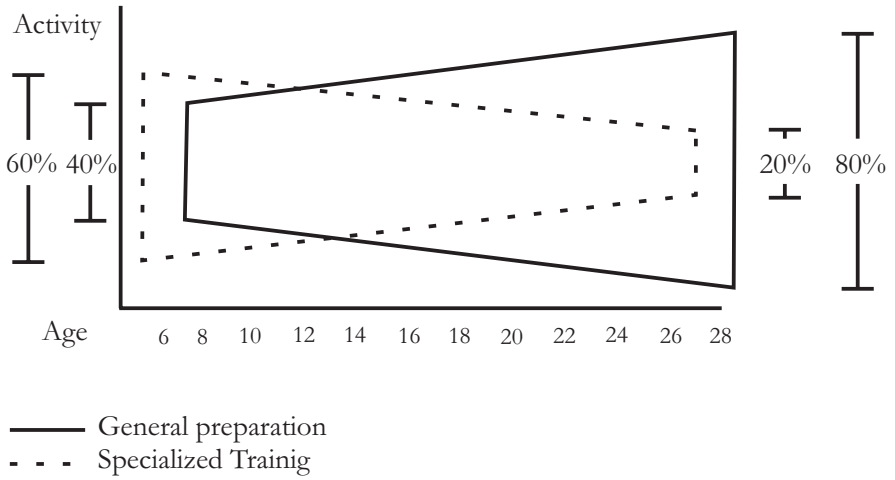
Početnički uzrast čine djeca starosti 7 do 10 godina. Djeca, u tom periodu života, su posebno osjetljiva za razvoj vještine koordinacije, brzine i agilnosti. Njihovi pokreti su veoma efikasni i precizni (Kasa, 2006). Prema istom autoru ovaj period se naziva "efekat prvog učenja". Mladi igrači u ovom uzrastu su u stanju da uče nove pokrete brže i sa većom efikasnošću. Neophodno je fokusirati se na specijalizovanu obuku, više nego na opštu pripremu (Slika 1).

FIGURE 1

Type of physical activity depending on age (Bompa, 2011; modified by Tománek, Argaj, & Schnűrmacher, 2003)

SLIKA 1

Tipovi fizičke aktivnosti u zavisnosti od uzrasta (Bompa, 2011; modifikovano od Tománek, Argaj, & Schnűrmacher, 2003)



Legend: Activity - Aktivnost; General preparation - Opšta priprema; Specialized trainig - Specijalizovani trening.

Preparing for the basketball season for 8-10 years old children should aim to develop and stabilized fundamental skills. The general concept of practice is focused on improvement of fundamental skills learned in pre-season and improved upon in the next level. Ortega, Manuel Palao, Sainz de Baranda, and García (2009), and Cañadas, Parejo, Ibáñez, García, and Feu (2009) shows a tendency of young players coaches to focus on offensive fundamentals.

Priprema za košarkašku sezonu za djecu 8–10 godina starosti treba imati za cilj da razvije i stabilizuje osnovne vještine. Opšti koncept treninga usmjeren je na poboljšanje fundamentalnih vještina naučenih u pripremnom periodu i poboljšan na sljedećem nivou. Ortega, Manuel Palao, Sainz de Baranda i Garcia (2009), i Cañadas, Parejo, Ibáñez, García i Feu (2009) pokazuju tendenciju trenera mladih igrača da se posvete fundamentima napada.

Accurate shooting can be developed by learning proper shooting technique at a young age. Argaj et al. (2003) emphasize the significance of practicing free throw shooting from distance determined by youth basketball rules.

Filippi and West (2011) recommend the shooting progression practice model as an useful reminder for coaches and players. That improvement happens over time and in progressive manner. Shooting practice model has three stages. Stage one - mechanics practice, stage two - repetition practice, stage three - competitive practice. Third stage is not recommended for young players.

Youth basketball rules respect all biological aspects of young players' bodies. The rules are modified for youth basketball players to support development of proper shooting technique at young ages without over exertion. Youth players practice and play matches on the lover baskets then adults (height of basket is 2.60 meter). During practice they used balls size 5 and 6. All season should be focused on shooting technique. If bad habits are formed in the beginning of learning basketball it will be difficult to eliminate them at an older age. Smooth body movement is necessary for shooting accurately (Mondoni, 2000; Velenský, 1987).

Shooting rhythm is important for building proper skills. Basic components of shooting rhythm are: balanced stance, hand position, body alignment and follow through. Practice goals should be to develop an automatic shooting mechanism (Fillipy & West, 2011).

According to Mačura (2010) shooting is characterized according to player' s movements: set shot (contact with base), the lay-up shot, and jump shot. Argaj et al. (2003) recommends the players to learn the lay-up by dribbling up from the right and left side of the court, the lay-up after passing and after a free throw.

Mondoni (2000), and Vogel and Brown (1992) believe that the lay-ups with right and left hands are necessary fundamental skills for youth basketball players. Mondoni (2000) advises for youth basketball players to learn to shoot after learning basketball skills such as dribbling and passing. Learning fundamental and proper shooting techniques is necessary to get motor skills. To develop excellent shooting techniques requires using various shooting drills, different intensities, aims and great variation.

This research was focused on the efficiency of specific shooting program to improve shooting accuracy of youth basketball players. We tested control and experimental groups and then compared their results. We presumed that the increase of shooting percentage in the experimental group was influenced by the designed shooting fundamental program.

Učenjem pravilne tehnike šutiranja u mlađem uzrastu može da se razvije njegova preciznost. Argaj i saradnici (2003) naglašavaju značaj vježbanja šutiranja slobodnih bacanja sa udaljenosti određnih pravilima minibasketa.

Filippi i West (2011) predlažu model progresivnog treninga šuta kao koristan podsjetnik za trenere i igrače. Poboljšanje se događa tokom vremena i na progresivan način. Model šuterskog treninga ima tri faze. Faza jedan - uvježbavanje mehanike, druga faza- ponavljajući trening, treća faza - situacioni trening. Treća faza se ne preporučuje mladim igračima.

Pravila minibasketa poštuju sve biološke zakonitosti tijela mladih igrača. Pravila su modifikovana za mlade košarkaše kako bi pomogla u razvoju odgovarajuće tehnike šutiranja bez pretjeranog napora u mlađim uzrastima. Mladi igrači treniraju i igraju utakmice na koševima koji su niži nego oni za odrasle (visina koševa je 2,60 metara). U treningu oni koriste lopte veličine 5 i 6. Na tehniku šutiranja treba obratiti pažnju tokom čitave sezone. Ako se loše navike formiraju u početku učenja košarke biće ih teško eliminisati u starijem uzrastu. Za precizno šutiranje potrebni su usklađeni pokreti tijela (Mondoni, 2000; Velenský, 1987).

Ritam šutiranja je važan za izgrađivanje odgovarajuće vještine. Osnovne komponente ritama šutiranja su: izbalansiran stav, položaj ruku, tijelo ispravljeno i završni pokret u zglobu šake. Trening treba da ima za cilj da razvije mehanizam automatizacije šutiranja (Fillipy i West, 2011).

Prema Mačura (2010) šutiranje se karakteriše prema pokretima igrača: šut iz mjesta (kontakt sa podlogom), polaganje i skok šut. Argaj i saradnici (2003) preporučuje igračima da nauče polaganje iz vođenja sa desne i lijeve strane terena, polaganje nakon dodavanja i nakon slobodnog bacanja.

Mondoni (2000) i Vogel i Brown (1992) vjeruju da su polaganja lijevom i desnom rukom neophodne fundamentalne vještine za mlade košarkaše. Mondonijev (2000) savjet za mlade košarkaše je da uče šutirati nakon što nauče košarkaške vještine kao što su vođenje i dodavanje. Učenje fundamenata i pravilne tehnike šutiranja je potrebno da se steknu motoričke sposobnosti. Razvijanje dobre tehnike šutiranja zahtijeva korištenje raznih vježbi šutiranja, različitog intenziteta, ciljeva i sa različitim varijacijama.

Ovo istraživanje je usmjereno na efikasnost specifičnog programa šutiranja za poboljšanje preciznosti šutiranja mladih košarkaša. Testirali smo kontrolnu i eksperimentalnu grupu, a zatim usporedili njihove rezultate. Pretpostavili smo da je porast procenta šuta u eksperimentalnoj grupi bio pod uticajem planiranog osnovnog programa šutiranja.

METHOD

Sample

Eighteen (n = 18) youth basketball players (age 9.85 ± .53 years old, height 1.50 ± .09 meter, experience 22.00 ± 9.43 months) volunteered and participated in this study. Players participated in 4 practices per week. The length of each practice was 90 minutes. They took part in a regional league for youth basketball for the first time in 2009/2010 season and finished in 4th place.

Procedures

Modified tests were chosen and implemented to find out the changes in movement abilities and skills (Argaj et al., 2003; Bös, 1988; Brace, 1966a, 1966b): the lay-up test, jumps shot 3 meter test, free throw test. For each test 10 attempts were recorded. Three modified tests were completed during the control and experimental period - the lay up modified test, free throw modified test, and stop jump modified test (Ibid). We used the Wilcoxon t-test to monitor significant differences and IBM SPSS 17 operation system for Microsoft Windows.

Single group crossover study-design, 32 weeks in duration, was conducted. Control time period took 16 weeks, and experimental time period took also 16 weeks. We conducted 3 measurements: first, at the beginning of the control period; second, at the end of the control period which was the beginning measurement of the experimental period as well. The last and third measurement, was at the end of experimental period. The control period consisted of 58 practice session, or 87 hours. They played 14 league games wich lasted 9 hours and 20 minutes. Overall amount of training load was 102 hours and 20 minutes. The experimental subject was practice focused on the shooting fundamental program and the improved of their shooting technique. The experimental period consisted of 55 practice sessions, or 83 hours and 30 minutes. They played 13 league games which lasted 8 hours and 40 minutes. Overall amount of training load was 96 hours and 40 minutes. Training program was focused on learning and improving fundamental skills and lasted 45 hours and 15 minutes (54.84%), where shooting practice consisted of 17 hours and 30 minutes in length (38.12%) (Figure 2). Specific shooting fundamental program was aimed at improving basic shooting mechanism and developing shooting technique. We applied 6 shooting drills with variations. Frequency of their application was 84 time during experimental period. Shooting drills were focused on: the lay ups shots, position shot from close and middle range, free throw shots, and under the basket shots

METODE

Uzorak

U ovoj studiji volonitiralo je i učestvovalo osamnaest (n = 18) mladih košarkaša (starosti 9,85 ± 0,53 godina, visine 1,50 ± 0,09 metara, sa iskustvom od 22,00 ± 9,43 mjeseci). Igrači su imali četiri treninga sedmično. Svaki trening trajao je 90 minuta. Oni su učestvovali u regionalnoj ligi za mlade košarke po prvi put u sezoni 2009/2010 i na kraju zauzeli 4. mjesto.

Procedure

Izabrani su i sprovedeni modifikovani testovi kako bi saznali promjene u kretnim sposobnostima i vještinama (Argaj i saradnici, 2003; Bos, 1988, Brace, 1966a, 1966b.): test polaganja, test skok šuta sa odstojanja 3 metara i test slobodnih bacanja. Za svako ispitivanje registrovano je 10 pokušaja. Tri modifikovana testa su sprovedena tokom kontrolnog i eksperimentalnog perioda - modifikovan test polaganja, modifikovani test slobodnih bacanja i modifikovani test skok šuta (Ibid). Koristili smo Wilcoxonov t-test za praćenje značajnih razlika i IBM SPSS 17 operativni sistem za Microsoft Windows.

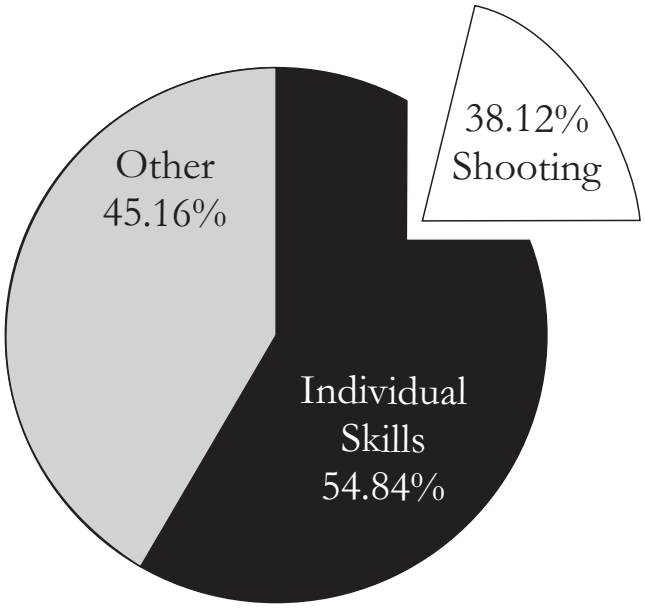
Sprovedena je crossover dizajnirano istraživanje na grupi u trajanju od 32 sedmice. Kontrolni vremenski period iznosio je 16 sedmica, a eksperimentalni takođe 16. Sproveli smo tri mjerenja: prvo, na početku kontrolnog perioda; drugo, na kraju kontrolnog perioda koji je istovremeno početak mjerenje u eksperimentalnom periodu. Posljednje, treće mjerenje, bilo je na kraju eksperimentalnog perioda. Kontrolni period sastojao se od 58 treninga, ili 87 sati. Oni su odigrali 14 liga utakmica koje su trajale 9 sati i 20 minuta. Ukupan iznos treninga opterećenje je 102 sata i 20 minuta. Predmet istraživanja bio je trening usmjerena na fundamentalni program šutiranja i poboljšanje njihove tehnike šutiranja. Eksperimentalni period sastojao se od 55 treninga, ili 83 sata i 30 minuta. Oni su odigrali 13 ligaških utakmica koje su trajale 8 sati i 40 minuta. Ukupan iznos opterećenja treninga je 96 sati i 40 minuta. Program treninga je bio usmjeren na učenje i usavršavanje fudamentalnih vještina i trajao je 45 sati i 15 minuta (54,84%), koji je obuhvatao i trening šuta u trajanju od 17 sati i 30 minuta (38,12%) (Slika 2). Specifični fundamentalni program šutiranja bio je usmjeren na poboljšanje osnovnog mehanizma šutiranja i razvoj tehnike šuta. Koristili smo 6 vježbi šutiranja sa varijacijama. Učestalost njihove primjene je bila 84 puta tokom eksperimentalnog perioda. Vježbe šutiranja bile su usmjerene na: polaganje, pozicioni šut iz blizine i sa poluodstojanja, slobodna bacanja i šut ispod koša

form left and right side. Shooting practices were competitive with time and space limitation (Zambová, 2011).

sa lijeve i desne strane. Šuterski treninzi bili su takmičarski u odnosu na vremenska i prostorna ograničenja (Zambová, 2011).

FIGURE 2
Ratio of individual skills and other activities during practice (%).

SLIKA 2
Odnos individualnih vještina i drugih aktivnosti tokom treninga (%).



Legend: Shooting - Šutiranje; Individual Skills - Individualne vještine; Other - Ostalo.

This kind of sport practice was applied in the experimental period by 20.5 % more than in control period. The individual skills were raised by 5%. Individual skills were more emphasised in experimental period due to shooting practice programme. As a result we wanted to get more difficult shooting drills compared to control period. Control period was characterized by using shooting drills without time limitation and without pressure of the opponents.

Ova vrsta sportskog treninga je primijenjena 20,5% više u eksperimentalnom nego u kontrolnom periodu. Pojedinačne vještine su unapređene za 5%. Individualne vještine su više naglašene u eksperimentalnom periodu zbog programa šuterskog treninga. Kao rezultat toga, željeli smo da se teže vježbe šutiranja uporede sa kontrolnim periodom. Kontrolni period karakterisalo je korišćenje vježbi šutiranja bez vremenskog ograničenja i bez pritiska protivnika.

RESULTS

In the lay up test (Figure 3) in the first measurement, we measured 2.33 ± 1.75 of successful attempts (23.30% shooting percentage). During the second measurement we got 3.78 ± 1.22 of successful attempts (37.80% shooting percentage). In the last and third measurement, there were 7.06 ± 2.83 successful attempts (70.60% shooting percentage). Data showed an increase in shooting accuracy in control period by 1.45 ($p < .01$) and in experimental period by 3.28 ($p < .01$). Significantly better results of the lay-up modified test were obtained in experimental period (1.83; $p < .01$).

REZULTATI

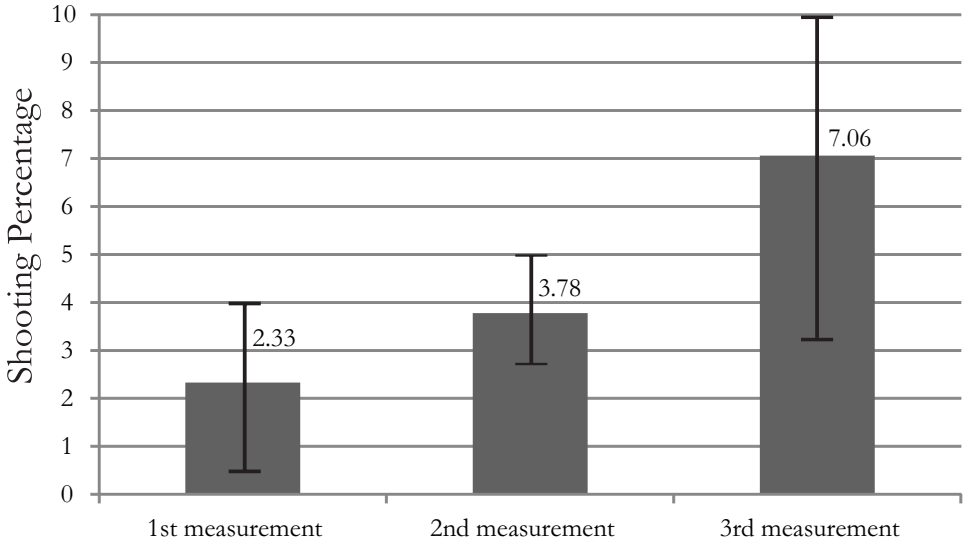
U testu polaganja (Slika 3) u prvom mjerenju, izmjerili smo 2,33 ± 1,75 uspješnih pokušaja (23,30% procenat šuta). Tokom drugog mjerenja dobili smo 3,78 ± 1,22 uspješnih pokušaja (37,80% procenat šutiranja). U posljednjem, trećem mjerenju, bilo je 7,06 ± 2,83 uspješnih pokušaja (70,60% proceant šuta). Podaci su pokazali povećanje preciznosti šutiranja u kontrolnom periodu od 1,45 ($p < 0,01$) i u eksperimentalnom periodu od 3,28 ($p < 0,01$). Značajno bolji rezultati modifikovanog testa polaganja dobijeni su u eksperimentalnom periodu (1,83; $p < 0,01$).

FIGURE 3

The lay-up modified test - increase of shooting percentage.

SLIKA 3

Modifikovani test polaganja - uvećanje procenta šuta.



Legend: Shooting Percentage - Procenat šutiranja; 1st mesurement - 1. mjerenje; 2nd measurement - 2. mjerenje; 3rd measurement - 3. mjerenje.

In the stop jump test (Figure 4) in the first measurement , we measured 3.11 ± 2.44 of successful attempts (1.10 % shooting percentage). During the second measurement we got 3.72 ± 1.53 of successful attempts (37.20% shooting percentage). In the last, third measurement we acquired, there were 4.07 ± 1.90 successful attempts (4.70% shooting percentage). Data results show an increase of shooting accuracy in control period of .61 and in experimental period of .34 shooting attempts. To compare the control and experimental increase we did not achieve any significant improvement of the stop jump modified test during experimental period. The results imply the improvement in the control period of .28 successful attempts. Statistically significant difference was not obtained in stop jump modified test.

In the free throw modified test (Figure 5) in the first measurement, we measured 2.39 ± 1.34 successful attempts (23.90% shooting percentage). During the second measurement we got 4.50 ±1.62 successful attempts (45.00% shooting percentage). The data results showed an increase of shooting accuracy in the control period by 2.11 ($p < .01$) shooting attempts, and in the experimental period by 1.45 ($p < .05$) shooting attempts. Improvement was not achieved from the free throw modified test in the experimental period. However, we achieved an improvement in control period by .67 ($p < .01$) successfull attempt.

U testu skok šuta (Slika 4) u prvom mjerenju, izmjerili smo 3,11 ± 2,44 uspješnih pokušaja (31,10% postotak šuta). Tokom drugog mjerenja dobili smo 3,72 ± 1,53 uspješnih pokušaja (37,20% postotak šuta). U posljednjem, trećem mjerenju, bilo je 4,07 ± 1,90 uspješnih pokušaja (40,70% postotak šuta). Podaci pokazuju uvećanje preciznosti šuta od 0,61 pokušaj u kontrolnom periodu i 0,34 pokušaja u eksperimentalnom periodu. Upoređujući kontrolno i eksperimentalno povećanje nismo utvrdili nikakav značajniji rast kod modifikovanog testa skok šuta tokom eksperimentalnog perioda. Rezultati ukazuju na poboljšanje u kontrolnom periodu od 0,28 uspješnih pokušaja. U modifikovanom testu skok šuta nisu dobijene statistički značajne razlike.

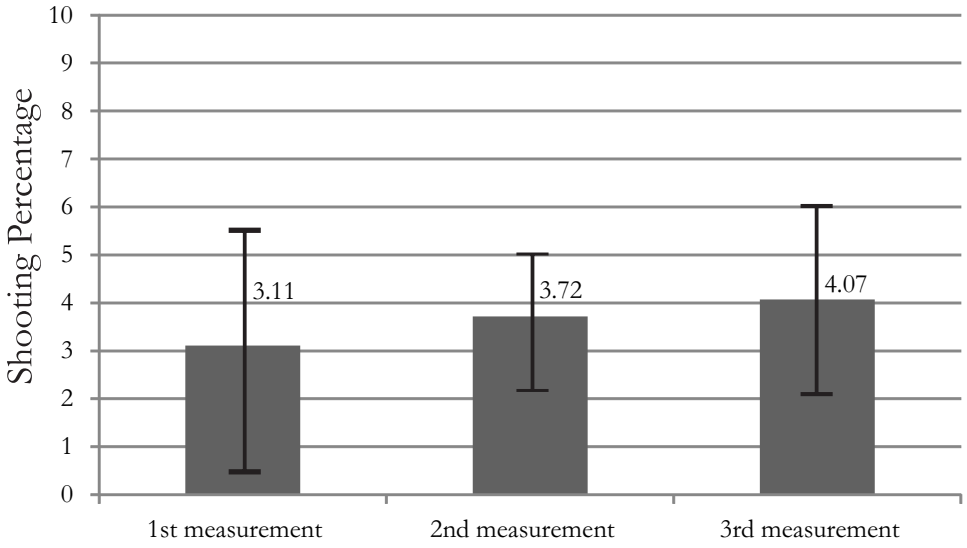
U modifikovanm testu slobodnih bacanja (Slika 5) u prvom mjerenju, izmjerili smo 2,39 ± 1,34 uspješnih pokušaja (23,90% postotak šuta). Tokom drugog mjerenja dobili smo 4,50 ± 1,62 uspješnih pokušaja (45,00% postotak šuta). Rezultati su pokazali povećanje preciznosti šutiranja u kontrolnom periodu od 2,11 ($p < 0,01$) pokušaja šutiranja te u eksperimentalnog periodu od 1,45 ($p < 0,05$) pokušaja šutiranja. Poboljšanje nije postignuto iz modifikovanog testa slobodnih bacanja u eksperimentalnom periodu. Međutim, postigli smo poboljšanje u kontrolnom periodu od 0,67 ($p < 0,01$) uspješnih pokušaja.

FIGURE 4

Stop jump modified test - increase of shooting percentage.

SLIKA 4

Modifikovani test skok šuta - uvećanje procenta šuta.



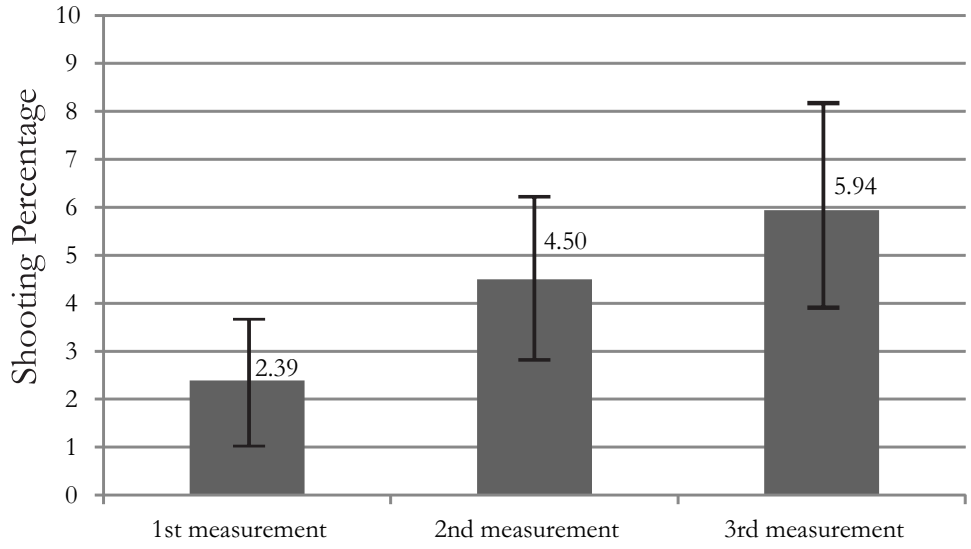
Legend: Shooting Percentage - Procenat šutiranja; 1st mesurement - 1. mjerenje; 2nd measurement - 2. mjerenje; 3rd measurement - 3. mjerenje.

FIGURE 5

Free throw modified test - increase of shooting percentage.

SLIKA 5

Modifikovani test slobodnih bacanja - uvećanje procenta šuta.



Legend: Shooting Percentage - Procenat šutiranja; 1st mesurement - 1. mjerenje; 2nd measurement - 2. mjerenje; 3rd measurement - 3. mjerenje.

DISCUSSION

The lay-up modified test result showed improvement in the experimental period of 1.84 ($p < .01$) successful

DISKUSIJA

Rezultati modifikovanog testa polaganja pokazali su poboljšanje u eksperimentalnom periodu od 1,84

attempts, and shooting percentage of 32.89%. Selected competitive drills were applied with ability to resist the defenders' pressure, ability to resist time limitation was effective. Results achieved statistically significant difference. The stop jump test results showed an improvement in the control period of .28 successful attempts, however no improvement was observed in the experimental period. Players reached 37.20% shooting percentage at the beginning of the experimental period. Shooting percentage was increased by 3.50% during the experimental period. The stop jump shooting percentage is sufficient for young players by Krause et al. (2008). Our experimental group of basketball players achieved 40.60% shooting percentage, which is more than Ibid claimed. The performance of the experimental group reached performance standard rating "excellent" for 3.55% successful attempts. The free throw test showed improvement in the control period by .67 (<.01) successful attempts. Players reached 59.40% shooting percentage at the end of the experimental period. Free throw shooting percentage was increased by 14.40% during the experimental period. There was minimal improvement in the free throw shooting percentage. This could be caused by focusing the player's attention on proper shooting technique, not on increasing their shooting percentage. It should be taken into account that after adaptation of free throw shooting, the learning process has not finished. However 60% shooting percentage of free throw according to consider Ibid is sufficient for young players. Performance of experimental group achieved standard rating "very good" for 6 successful attempts by Argaj et al. (2003). None of the shooting modified tests proved decrease of shooting percentage. There was a slight increase in each measurement. It is important to mention the possibility that the players could achieve low shooting percentage in the beginning of control period due to pre-season. Players have 1.5 month off season, without regular practice. First measurement was realized after two weeks of general practice preparation.

CONCLUSION

Shooting accuracy is a well known aspect for rating the quality of basketball player and team. Greater percentage of shooting the players achieve the greater is their possibility to play in a professional league. Pavlidou, Michalopoulou, Aggeloussis, and Kioumourtzoglou (2006) demonstrated that there is a great influence of motor movement abilities on basketball skills, because according to mentioned study basketball players had better reaction time in comparison with other participants. Shooting and perception tests

($p < 0,01$) uspješnih pokušaja i postoku šuta od 32,89%. Primjenjene su odabrane takmičarske vježbe sa mogućnošću da se suprotstavi pritisku protivnika i sposobnost da se efikasno odupre vremenskim ograničenjima. Postignuti rezultati statistički se značajno razlikuju. Rezultati testa skok šuta pokazali su poboljšanje u kontrolnom periodu od 0,28 uspješnih pokušaja. Međutim, poboljšanje nije zabilježeno u eksperimentalnom periodu. Igrači su dostigli 37,20% procenta šuta na početku eksperimentalnog perioda. Procenat šuta povećan je za 3,50% tokom eksperimentalnog perioda. Po Krausea i saradnicima (2008) taj procenat skok šuta je dovoljan za mlade igrače. Naša eksperimentalna grupa košarkaša ostvarila je postotak od 40,60% što je više nego što je tvrdio Ibid. Eksperimentalna grupa postigla je standardnu ocjenu izvođenja "izvrsno" sa 3,55% uspješnih pokušaja. Test slobodnih bacanja pokazao je napredak u kontrolnom periodu od 0,67 (< 0,01) uspješnih pokušaja. Igrači su dostigli procenat šuta od 59,40% pri kraju eksperimentalnog perioda. Procenat šuta slobodnih bacanja je povećan za 14.40% tokom eksperimentalnog perioda. Postojao je minimalan napredak u procentu šutiranja slobodnih bacanja. Uzrok tome može da bude fokusiranje igrača na pravilnu tehniku štiranja, a ne na povećanje njihovog procenta šuta. Treba imati u vidu da nakon adaptacije na izvođenje slobodnih bacanja proces učenja nije završen. Prema Ibid procenat šuta od 60% kod slobodnih bacanja je dovoljan za mlade igrače. Po Argaj i saradnicima (2003) eksperimentalna grupa je postigla učinak uz standardnu ocjenu "vrlo dobar" sa 6 uspješnih pokušaja. Nijedan od modifikovanih testova šuta nije pokazao pad procenta šuta. Došlo je do blagog porasta u svakom mjerenju. Važno je napomenuti i mogućnost da su igrači mogli postići nizak procenat šuta na početku kontrolnog perioda zato što su se nalazili u predsezoni. Igrači provode 1,5 mjeseci u prelaznom periodu, bez redovnog treninga. Prvo mjerenje je realizovano nakon dvije sedmice opšte pripreme.

ZAKLJUČAK

Šuterska preciznost je dobor poznat aspekt za ocjenu kvaliteta košarkaša i košarkaškog tima. Veći procenat šuta igračima pruža veću mogućnost da zaigraju u profesionalnoj ligi. Pavlidou, Michalopoulou, Aggeloussis i Kioumourtzoglou (2006) su dokazali da postoji velik uticaj kretnih motornih sposobnosti na košarkaške vještine, pošto, u skladu s navedenim istraživanjem, košarkaši su imali bolje vrijeme reakcije u poređenju sa ostalim učesnicima. Testovi šutiranja i percepcije pokazali su takođe visoku korelacionu

showed high correlation dependence as well. We focused on practicing and improving shooting in young basketball players. Results showed an increase in shooting accuracy by applying selected shooting drills. Basketball players showed a significantly better results in the lay-up modified test. They improved in jump shot modified test, and free throw modified test. The study was focused on offense skills, specialized on improvement of shooting in the practice program for youth basketball players. Significantly better result of the lay-ups could be explained by using them very often in that age category. The research confirmed that it was possible to achieved statistically significant progress in practice process by using shooting fundamental program. Male and female players created experimental group in youth basketball category. Combined gender education of youth basketball teams exist in young category. Research is recommended to be completed in other categories, especially in older age groups. Individual improvements could be seen during experiment. We achieved improvement with every player. These results could be compared with players in higher categories often using the lay-ups and jump shot from longer distance. Experiment could be repeated in other categories or in older age on same experimental group. Practice manual of shooting drills could be useful for coaches and teachers of physical education.

zavisnost. Mi smo se fokusirali na trening i poboljšanje šutiranja kod mladih košarkaša. Rezultati su pokazali povećanje preciznosti šuta primjenom odabranih vježbi za šut. Košarkaši su pokazali statistički značajno bolje rezultate u modifikovanom testu polaganja. Oni su poboljšali i modifikovani test skok šuta i modifikovani test slobodnih bacanja. Istraživanje je bilo usmjereno na napadačke vještine i specijalizovano za poboljšanje programa treninga šuta mladih košarkaša. Znatno bolji rezultati kod polaganja se mogu objasniti činjenicom da se ona vrlo često koriste u ovoj starosnoj kategoriji. Istraživanje je potvrdilo da je moguće postići statistički značajan napredak u procesu treninga korišćenjem fundamentalnih programa šuta. Eksperimentalna grupa je formirana od dječaka i djevojčica mlađih košarkaških kategorija. Formiranje košarkaških timova kombinovanih od oba pola postoji u mlađim kategorijama. Preporučujemo da se istraživanje uradi i u drugim kategorijama, a posebno u starijim starosnim grupama. Tokom eksperimenta mogu da se vide individualna poboljšanja. Postigli smo napredak sa svakim igračem. Ovi rezultati se mogu uporediti s igračima iz starijih kategorija koji često koriste polaganje i skok šut sa veće udaljenosti od koša. Eksperiment se može ponoviti sa drugim kategorijama ili sa istom grupom kada pređu u stariju starosnu grupu. Priručnik sa vježbama šutiranja može koristiti trenerima i nastavnicima fizičkog vaspitanja.

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ÚČINNOSŤ STRELECKÉHO TRÉNINGOVÉHO PROGRAMU MINIBASKETBALISTOV

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Overenie účinnosti tréningového programu so zameraním na streľbu minibasketbalistov. Zaznamenanie zmien stavov testami a následne porovnanie zmien stavov v kontrolnom a experimentálnom období. Predpokladali sme zvýšenie úspešnosti streľby počas experimentálneho obdobia vplyvom tréningového programu.

Skúmaný súbor tvorilo 18 minibasketbalistov a minibasketbalistiek. Priemer decimálneho veku súboru je 9,85 ± 0,53 roka. Na zisťovanie zmien pohybových schopností a zručností sme využili modifikované testy od Argaj et al. (2003): streľba v pohybe po dvojtakte, streľba vo výskoku zo vzdialenosti 3 metre, streľba trestných hodov zo vzdialenosti 4 metre od dosky. Pri testoch bol zaznamenávaný počet daných košov z 10 možných pokusov. Na zistenie rozdielov nameraných hodnôt kontrolného a experimentálneho obdobia sme použili Wilcoxonov T test. Organizácia jednoskupinového časovo nesúbežného experimentu bola rozdelená do dvoch období, kontrolného a experimentálneho. Kontrolné a experimentálne obdobia trvali po 16 týždňov. Experimentálnym činiteľom bol tréningový program so zameraním na nácvik a zdokonaľovanie streľby. Vytvorené cvičenia mali súťažný charakter, s prevahou pohybu s nutnosťou využívania zmeny smeru a rýchlosti.

Výsledky práce poukazujú na zvýšenie úspešnosti basketbalovej streľby aplikáciou vybraných streleckých cvičení. Signifikantné zlepšenie sme zaznamenali pri teste streľby po dvojtakte o 1,84 ($p < 0,01$) úspešného pokusu, zlepšená percentuálna úspešnosť streľby o 32,89%. V teste streľby vo vzdialenosti 3 metre došlo k zvýšeniu úspešnosti streľby o 3,50% v experimentálnom období. V teste streľba trestných hodov došlo k percentuálnemu zvýšeniu úspešnosti streľby o 14,40% v experimentálnom období. Zvýšenie úspešnosti basketbalovej streľby sme preukázali v tréningových podmienkach. Výskum navrhujeme realizovať v rôznych vekových kategóriach, kde hráči v tréningu častejšie využívajú streľbu z väčších vzdialeností . Následne výsledky porovnať.

Kľúčové slová: mládež, základné pohybové zručnosti, streľba, úspešnosť streľby, úspešnosť, technika.

GUIDELINES FOR AUTHORS

Journal intention

SportLogia journal covers the areas of sports and physical education. It is issued twice a year and publishes original scientific papers, reviewed scientific papers, scientific gathering presentations, short scientific articles and professional articles from the area of sports, physical education, recreation, kinesiology anthropology, training methods, sport biology and exercise, sport medicine, biomechanics, sport history and sport management as well as contributions from other sciences (medicine, sociology, psychology, philosophy, exact sciences and mathematics) applied in sports.

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If the author has corrected the text in accordance with the instructions from the editor, the manuscript is sent for review. In that case, the author will be given a form called *Copyrights Declaration*, which needs to be filled in and sent back to the editor. The signature of the author verifies the authenticity of the text, authorship and acceptance of the review procedure.

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Časopis SportLogia iz oblasti sporta i fizičkog vaspitanja izdaje se dva puta godišnje i objavljuje izvorne naučne članke, pregledne naučne članke, kratke naučne članke, izlaganje sa naučnog skupa i stručne članke iz područja sporta i sportskih aktivnosti, fizičkog vaspitanja, rekreacije, kineziološke antropologije, trening metoda, biologije sporta i vježbanja, sportske medicine, biomehanike, istorije sporta i menadžmenta u sportu kao i priloge iz drugih nauka (medicine, sociologije, psihologije, filozofije, prirodnih nauka i matematike) primjenjenih na sport.

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Svi rukopisi dostavljaju se uredništvu časopisa koji, nakon što ih pročita, određuje dalji postupak: (1) odmah šalje rukopis na recenziju; (2) ako ima određenih primjedbi i sugestija, rukopis vraća autoru na doradu; (3) odbija rukopis. Urednik može da odbije rukopis u sledećim slučajevima: (1) tema koju obrađuje rukopis nije relevantna; (2) rukopis sa sličnom temom već je objavljen u časopisu; (3) rukopis ne ispunjava standarde časopisa. Ukoliko rukopis nije prihvaćen, autoru se šalje kratko obavještenje, ali rukopis se ne vraća.

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group of researchers whose aim is to summarize, analyze, evaluate or synthesize already published information. It brings new syntheses which also include results of author's own research.
- *Short scientific article* is an original scientific article which may skip some elements of IMRAD. It concisely presents results of a completed own research or of an ongoing research.
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Scientific articles must adhere to the IMRAD scheme (Introduction, Methods, Results and Discussion).

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The title page of the manuscript should contain the following information: (1) a concise, but informative title. Use of abbreviations is not encouraged; (2) the author's names (do not include degrees); the last one is introduced by "&"; (3) the affiliation of the authors, town and state; (4) the name and address of the corresponding author (must include title, degree and position of the corresponding author, phone and fax numbers – zip code for the country and city, and email address).

Summary, large summary and key words

The summary should be brief and Self-explanatory. It should cover a general presentation of the topic (the purpose and the objective of the paper), results and conclusions. Authors should not use abbreviations. The abstract should include 150-250 words. Authors from abroad write the large summary in their native languge (the summary has to be reviewed), and the authors whose native language is BCS write the mentioned summary in

radova pojedinog istraživača ili grupe istraživača sa ciljem da se već publikovane informacije sažmu, analiziraju, evaluiraju ili sintetizuju. Donose nove sinteze koje, takođe, uključuju i rezultate sopstvenog istraživanja autora.
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Velik sažetak ne smije da pređe 1800 karaktera (do tri stranice u duplom proredu), i treba da sadrži naslov rada, ključne riječi i tekst sažetka. Autori iz inostranstva veliki sažetak pištu na maternjem jeziku (sažetak

one of the official languages of the IOC Assembly (article 27 of Olympic Charter), except English. The translation should be made by relevant person.

Large summary should not exceed 1800 characters (up to tree pages of double spaced text), and should include title, keywords and summary text.

Three to six words, which are not part of the title, need to be singled out. The Key words need to reflect the contents of the paper.

Introduction

This part of the paper ought to inform the reader of the issues dealt with in the research and the results of previous analyses. The purpose of the research should also be clearly stated in this part.

Methods

This part should consist of the following subtitles: entity sample, variables, procedures, tastings, statistical analysis.

Units of measurement, symbols and abbreviations must conform to international standards. Measurements of length, height, weight and volume should be given in metric units (meter, kilogram, liter).

Results

The results should be presented as tables, graphs and pictures, possibly processed statistically and be concisely presented in the text.

Tables, graphs and pictures showing the results of individual analyses need to be indicated in the text for easier reader navigation.

Discussion

The authors are expected here to comment on the results and compare them with literature data. The discussion must be professional and correspond to experimental data. Practical implications are welcome.

Conclusion

Contains clearly stated scientific assertions, open issues and recommendations for further research.

Tables, graphs and pictures

Each table and any illustration (black and white only) must be submitted on a separate sheet of paper. Tables should be numbered in the order in which they occur in the text and referred to as, for example, "Table 1.". Each table should be accompanied by a short title. Tables should be accompanied with interpretations (legends). It will also be deemed informative if the tables include indications of important correlations and relevant variables.

mora da bude lektorisan), a autori kojima je maternji jezik BHS ovaj sažetak pišu na jednom od jezika Međunarodnog olimpijskog komiteta, naravno osim engleskog, na koje se simultano prevodi na svim Skupštinama MOK-a (član 27 Olimijske povelje). Prevođenje mora da uradi stručna osoba.

Potrebno je izdvojiti i dati tri do šest ključnih riječi koje se ne nalaze u naslovu. Ključne riječi moraju da odražavaju suštinu sadržaja rada.

Uvod

Ovaj dio rada treba da informiše čitaoca o problemima datog istraživanja i rezultatima prethodnih analiza. Cilj istraživanja takođe treba jasno navesti u ovom dijelu.

Metode

Ovaj dio treba da se sastoji od sledećih podnaslova: uzorak entiteta, varijable, procedure testiranja, statistička analiza.

Mjerne jedinice, simboli i skraćenice moraju da poštuju međunarodne standarde. Mjere dužine, visine, težine i zapremine moraju da budu u metričkim jedinicama (metar, kilogram, litar).

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Tabele, grafikoni i slike koje pokazuju rezultate pojedinih analiza trebaju da budu naznačene u tekstu kako bi se pažnja čitaoca skrenula na njih.

Diskusija

Od autora se očekuje da iznesu dokaze istraživanja i da ih uporede sa dosada objavljenim istraživanjima u toj oblasti. Diskusija mora da bude stručna i u skladu sa podacima eksperimenta. Poželjno je da diskusija obuhvati i praktične implikacije rada.

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Sadrži jasno izrečene naučne tvrdnje, otvorena pitanja i preporuke za daljnja istraživanja.

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Svaka tabela, grafikon i slika (samo u crno bijeloj tehnici) treba da bude dostavljena na posebnom listu papira. Tabele treba da budu numerisane po redoslijedu kojim se pojavljuju u tekstu i označena kao npr. "Tabela 1". Svaka tabela treba da ima kratak naslov. Potrebno je dodati legende za tabele. Takođe bilo bi informativno ako bi se u tabelama naznačile značajnije korelacije i značajnije varijable.

Illustrations, graphs and pictures shall be marked as "Figure 1". Photographs are sent in electronic form in a resolution not smaller than 300 dpi and in a .jpeg format. Each figure needs to have a short title. In case that the figures are taken over from another paper, the title should not include the original name. In such a case, the source where the picture was taken from should be indicated under the picture.

If tables, graphs and pictures contain special symbols, or are prepared in a special program, they must be submitted in a separate file, with clearly indicated order of their inclusion in the text.

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Texts are to be written in Microsoft Word Windows program, on A4 paper format. Text is to be written in the Times New Roman font, size 12 pt in 1.5 spacing, aligned on both sides, with a 1 tub denting of the first row of a paragraph, with 2.5 cm paper margins. If it is necessary to indicate a word or a sentence in the text, use the italic. Text size should conform to 15 pages. The editorial board may accept a bit longer papers, but it will seldom do so.

Articles and abstracts should be written in the third person, neutrally, adhering to a good style and defined linguistic norms.

Refereneces

The journal uses the Harvard reference system - APA standards for referencing literature.

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Ukoliko tabele, grafikoni i slike sadrže posebne znakove, te su rađeni u posebnom programu, dostavljaju se na posebnom fajlu, sa tačno navedenim rasporedom po kojem se uključuju u tekst.

Tehničko oblikovanje članka

Članci se pišu i štampaju latiničnim pismom, po potrebi i drugim pismima, na srpskom (ijekavica) i engleskom jeziku. Svako odstupanje od navedenog, treba posebno unaprijed dogovoriti s Uredništvom. Ako se radi o autorima kojima maternji jezik nije srpski, hrvatski ili bošnjački njihove radove na srpski prevodi uredništvo. Autori su dužni da prilikom prevođenja rada na engleski jezik angažuju stručne osobe, najbolje one kojima je maternji jezik engleski.

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