SPORT SCIENCE

INTERNATIONAL SCIENTIFIC JOURNAL OF KINESIOLOGY

NIA
Association for Research, Education and Development
Travnik, Bosnia and Herzegovina

SPORT SCIENCE
INTERNATIONAL SCIENTIFIC JOURNAL OF KINESIOLOGY
Vol. 10, Issue 1. June 2017
Print ISSN 1840-3662, Web ISSN 1840-3670UDK 796,
Catalogued in: COBISS BH

Publisher
Association for Research, Education and Development "NIA"Aleja konzula 5, Travnik, Bosnia and Herzegovina

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Print:
Print d.o.o.Travnik
Circulation: 300 copies

Communication
Association for Research, Education and Development "NIA"Aleja Konzula 5, Travnik, Bosnia and Herzegovina
Tel: +387 (0)30 540 876
GSM:+387 (0)61 475 922
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Publishing
Sport Science publishes twice a year in English with Bosnian abstracts.
Full journal text avaliable on http://www.sportscience.ba/

Indexed in
'CAB Abstracts', 'CABI Leisure Recreation and Tourism Abstracts', 'CABI Leisure Tourism Database', 'CABI Global Health', 'CABI Nutrition Abstracts and Reviews Series A: Human and Experimental', 'SafetyLit', 'FSO', 'CABI Abstracts on Hygiene and Communicable Diseases', 'Elsevier Scopus', 'Open-J Gate', 'getCITED', 'ProQuest CSA Physical Education Index', 'ProQuest CSA Natural Sciences', 'ProQuest CSA Social Sciences' 'Genamics Journal Seek', 'Electronic Journals Index (SJSU)', 'Directory of Open Access Journals (DOAJ), 'EBSCO SPORTDiscus with Full Text', 'EBSCO TOC Premier', 'EBSCO Current Abstracts', 'Index Copernicus', 'EZB - Electronics Journals Library', 'Scientific Journal Impact Factor (SJIFactor)', 'Directory of Research Journals Indexing (DRJI)' , 'Universal Impact Factor (UIF)', 'ROOT INDEXING - Journal Abstracting and indexing service', 'ESJI - Eurasian Scientific Journal Index', 'ROAD - Directory of open access scholary resources', 'Academic Keys', 'Academic Resource Index - Research BIB', 'WCOSJ - World Catalogue of Scientific Journals', 'DAIJ - Directory of Abstract Indexing for Journals', 'I2OR - International Institute Of Organized Research', 'JournalIndex.net', 'OCLC - WorldCat', 'SIS - Scientific indexing service', 'IIJIF - International Innovative Journal Imact Factor', 'IFSIJ - Impact Factor Services For International Journals', 'Open Academic Journals Index - OAJI', 'Scholarsteer - Scholartly Information', 'Scientific world index - sciwindex', 'Journal Impact Factor - JIFACTOR', 'Journal Factor'

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DEAR READER,

You have before you a new issue of the magazine SPORT SCIENCE. Just as we have announced in the previous issue, promoting the magazine at a global level is the strategic goal of the management and our vision of the future. Becoming visible and available in the world databases is an orientation that requires quality, excellence and originality in the scientific approach to research and authorship.

The path towards accomplishing our goal is filled with obstacles and demands that have to be met. Our Editorial Board is aware of the responsibility and the difficulty of the task at hand, but we are determined in our intent to make our ideas a reality and offer new contents to readers in each issue.

This issue presents scientific papers from 12 countries and 4 continents:
The United States of America, Iran, Brazil, Indonesia, Germany, Macedonia, Serbia, Bulgaria, Montenegro, Kosovo, Croatia and Bosnia and Herzegovina.

Out of the 18 published papers in this issue, 4 papers belong to the area of sports medicine, 9 to the area of transformation processes, 3 to the area of sports management, 1 to the area of biomechanics and 1 to the area of kinesiological education.

The very choice of papers, number of countries, as well as institutions the authors come from are an indicator of our commitment to make the magazine SPORT SCIENCE a global story and a project that will spread the energy contained in the spirit of sports throughout the world.
Connecting institutions, researchers, and networking with the goal of promoting new ideas, joint scientific papers and new values is our mission where everyone who shares our vision is welcome!

We strive to become a part of new values, we wish to share our ideas with others and want to be placed on a path that has no barriers and obstacles, only challenges and opportunities.
We are aware that we have to keep up with the changes and that systems where innovation is not followed are doomed to fail. We have chosen to follow the development of new technologies in the world of sports and our task is to seek out new contents and results.

We are very pleased with the fact that the interest in SPORT SCIENCE has been growing towards a global level and that we receive a large amount of papers that have to wait for an opportunity to be published.

The authors and institutions they come from show that our vision has a future in which you, our faithful readers, will be our best critics. We want to fulfil our promises and justify the readers trust in us, all the while being aware that only the quality of papers can evoke your pleasure and capture your attention!

Dr. Nihad Selimović, MSc
Editor in chief

DRAGI ČITATELJU,

Pred Vama je novi broj časopisa SPORT SCIENCE. Kao što smo najavili u predhodnom broju, promovisanje časopisa na globalnom nivou je strateški cilj menadžmenta i naša vizija budućnosti. Postati vidljiv i dostupan u svjetskim bazama je orjentacija koja zahtjeva kvalitet, izvrsnost i orginalnost u naučnom pristupu istraživanja i stvaralačkom radu.

Put do našeg cilja pun je prepreka i zahtjeva koji se trebaju ispuniti. Naš urednički tim je svjestan odgovornosti i težine zadataka ali smo odlučni u namjerama da naše ideje pretvorimo u stvarnost i da čitateljima u svakom broju ponudimo nove sadržaje.

U ovom broju imamo naučne radove iz 12 zemalja sa 4 kontinenta:
Sjedinjene Američke Države, Iran, Brazil, Indonezija, Njemačka, Makedonija, Srbija, Bugarska, Crna Gora, Kosovo, Hrvatska i Bosna i Hercegovina.

Od 18 radova koliko smo ih objavili u ovom broju, 4 rada su iz oblasti sportske medicine, 9 radova je iz transformacionih procesa, 3 rada su iz oblasti sportskog menadžmenta,1 rad obrađuje temu iz oblasti biomehanike i 1 rad je iz područja kineziološke edukacije.

Sam odabir radova, broj zemalja kao i institucije sa kojih autori dolaze, pokazatelj su našeg opredjeljenja da časopis SPORT SCIENCE postane globalna priča i projekat koji će širiti energiju sportskog duha širom svijeta.

Povezivanje i umrežavanje institucija, istraživača u cilju promicanja novih ideja, zajedničkih radova i novih vrijednosti naša je misija u kojoj su svi koji dijele našu viziju dobrodošli!

Želimo biti dio novih vrijednosti, želimo dijeliti ideje sa drugim i želimo biti na putu koji nema barijere i prepreke već ima izazove i šanse.

Svjesni da moramo biti u korak sa promjenama i da su sisetmi koji ne prate inovacije osuđeni na propast, opredjelili smo se za praćenje razvoja novih tehnologija u svijetu sporta i naša zadaća je traganje za novim sadržajima i rezultatima.

Sretni smo što interes za SPORT SCIENSE poprima globalnu širinu i što dobivamo veliki broj radova koji moraju čekati priliku da budu objavljeni.

Prema autorima i institucijama iz kojih autori dolaze, pokazujemo da naša vizija ima budućnost u kojoj ćete Vi, naši vjerni čitatelji, biti naši najbolji kritičari.Želimo ispuniti naša obećanja i opravdati povjerenje čitatelja svjesni da jedino kvalitet radova može kreirati Vaše zadovoljstvo i pridobiti Vašu pažnju!

Dr. Nihad Selimović, MSc
Editor in chief

SPORTS-RELATED CONCUSSIONS: AN UPDATE ON DIAGNOSIS, TREATMENT AND MANAGEMENT (UNBLINDED)

Jared Wolfe, Daniel Christensen, Scott Pyne, Lance E LeClere

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ABSTRACT

Context: Concussions represent the second highest source of sports related morbidity, behind only sprains and strains. As the potential devastating consequences of these injuries are better elucidated, it becomes vital for sports medicine physicians to understand how to appropriately manage concussions in athletes. This paper reviews the latest data on our understanding of the pathophysiology of this complex process, along with the current recommendations for diagnosis, treatment and management. Evidence Acquisition: Recent literature was reviewed for articles related to the pathophysiology, diagnosis, treatment and management of concussions. Study Design: Clinical Review Level of Evidence: IV Results: Concussions are one of the largest causes of Sports related morbidity at all levels of competition. Recent research has enhanced our understanding of the pathophysiology of the condition and improved our ability to diagnose and treat them. Conclusion: The substantial number of athletes who sustain a concussion each year combined with the potentially devastating short and long-term consequences of concussions create a substantial burden of disease. In order to maximize patient outcomes and reduce morbidity, coaches, athletic trainers and physicians need to be aware of how to appropriately diagnose and manage a concussed athlete. The goal of this paper is to present our current best practices for diagnosis, treatment and management of concussions, along with our current understanding of the complex neurophysiologic changes that take place.

Keywords: Concussion, traumatic brain injury, sports medicine, return to play and chronic traumatic encephalopathy.

INTRODUCTION

The 2016 United States Physical Activity Council Report estimates that 150 million Americans participate in some form of athletic activity on a monthly basis. This high level of participation places many Americans at risk for sports-related injuries, of which concussions are the second largest source of morbidity, behind only sprains and strains. Over 1.5 million sports-related concussions are reported on a yearly basis. However, due to continued issues with reporting and diagnosis, many experts believe that this number is an underestimate. Although the signs of symptoms for most concussions resolve within a couple of days, there is increasing evidence that concussions may lead to more detrimental long-lasting sequela, to include dementia and early cognitive decline. This increased understanding of the potential long term consequences of concussions, along with high profile cases receiving increased media attention, have led to a surge in research on sports-related concussions.48Over eight hundred articles were published on the subject in the first ten months of 2016 compared to the mere 146 that were published in 2006.

A newfound societal concern regarding the rates and long term consequences of concussions has led to multiple initiatives by governmental and non-governmental organizations to reduce the incidence of sports-related concussions. In 2009, Washington was the first state to pass a return to play law for youth sports, a precedence which has been followed by the remaining 49 other states. Additionally, over the past several years the National Football League (NFL) has implemented many rule changes with the goal of decreasing

concussions by reducing the number of hits to the head. Following the implementation of these new rules, the 2013-14 season saw a 12% reduction in the incidence of concussions when compared with the prior season. Despite this recent trend, the current concussion rate is still 61% higher than what was reported in the 2002-2007 seasons. In 2010, the National College Athletic Association (NCAA) released a new concussion management plan, which requires baseline neurocognitive testing, increased accountability of athlete-based reporting, and mandatory time off following concussions. Following the institution of these new policies, concussion incidence among Division I football players at the three US military academies rose to 82%. It is important to note that the authors of this study, along with the NFL, attribute this higher incidence to more accurate reporting and not to a true increase in concussion incidence.

Concussion rates have also been increasing at the youth sports level. From 2002 to 2012 concussion incidence rose by almost 400% among 4-13 year-olds. In a similar time period, from 2005 to 2012, the rate among high school athletes also doubled. While it is true that the increasing incidence of sports-related concussions is strongly correlated with the implementation of these new policies and likely related to an overall increasing awareness and recognition of this phenomenon, the potential short and long term consequences for athletes of all ages cannot be overstated. The potentially devastating outcomes make concussion-related research a vital area of focus for sports medicine physicians and researchers.

PATHOPHYSIOLOGY

The 4th International Sports Conference on Concussions and the American Medical Society for Sports Medicine have both developed consensus statements that define a concussion as a "traumatically induced disturbance of brain function caused by a complex physiologic process." The ambiguity of this statement reveals a lack of understanding regarding the exact pathophysiologic changes taking place in the human brain following a concussion. Through the use of animal models, an understanding of the phases of injury and recovery as well as the biochemical changes associated with each has been developed. Following a traumatic insult to the brain, there is a massive depolarization of the neurons and a large release of the neurotransmitter glutamate. This results in a disruption of cellular homeostasis to which the brain responds with increased glucose consumption. However, at the same time, the cerebral blood flow is decreased, leading to an uncoupling of metabolic supply and demand. This uncoupling effect results in mitochondrial dysfunction and can lead to cellular apoptosis. Histologic examination of rats' brains shows increased presence of neuronal cell vacuolation and nuclear condensation, signs of significant cellular injury, which were already present on pathologic examination performed one hour following the concussive injury and peaked at around 48 hours. These alterations in cellular biology and metabolism are believed to be responsible for "Second Impact Syndrome", which is an increased susceptibility and worse prognosis for recovery when a second concussion occurs prior to recovery from the first. In animal models, this initial hypermetabolic state is followed by a period of decreased metabolic activity for about 7-10 days, in which decreased neurocognitive functioning has been noted. Although the same studies are not possible for human subjects, PET scans performed in concussion patients show patterns of glucose metabolism that are similar to those seen in animals.

EVALUATION

Initial evaluation of an injured athlete at the high school level of competition and above is typically performed on the field by an athletic trainer or a sideline physician. At lower levels of competition, this is often the role of the parents or coaches. Initial evaluation should follow basic first aid (emergency management) principles including cervical spine assessment. In otherwise medically stable patients, whose cervical spine is cleared, a sideline assessment for concussion should be performed.

The primary purpose of the sideline assessment is to diagnose the presence of a concussion, or to clear the athlete for return to play. The National Athletic Trainers Association recommends this exam to include an assessment of symptoms, physical and neurological exam, and balance testing. Additionally, whenever possible, they recommend the use of a concussion-evaluation tool such as the Standardized Concussion Assessment Tool 3 (SCAT3), which includes the Standardized Assessment of Concussion (SAC).6These recommendations have been adopted as official guidelines by the NCAA.

During the assessment of symptoms, the provider should be cognizant of any symptoms suggesting a concussion has taken place. Although loss of consciousness and confusion are two of the classic signs, they are only seen in 5% and 43% of concussions, respectively. Headache and dizziness, however, are seen in 93% and 75% of concussions.42Further complicating the initial assessment is the potential for the athlete to withhold reporting their symptoms. A survey of

3600 previous Division I athletes, who played between 1987 and 2012, revealed a 33% nondisclosure rate among all athletes with the highest rate (68%) seen in football players and the lowest (14%) seen among female athletes. The most common reasons for non-disclosure included failing to recognize concussion symptoms, not wanting to miss game time, and feeling like they would let their team down.

Further evaluation consists of a standard physical exam and oftentimes the use of a required sideline screening tool. It is becoming common practice in many organizations for these screening tools to be required for the athlete to return to play and, as mentioned earlier, they are required in NCAA competitions. Even in situations where they are not required, they serve as a useful tool for the evaluating provider.A commonly used example is the SCAT-3, which consists of 3 components: a symptom checklist, the SAC and the modified Balance Error Scoring system (mBESS). Overall, the SCAT-3 has shown excellent sensitivity and specificity with a Receiver Operator Area Under the Curve of .88.

These tests, however, are not perfect and changing multiple variables affects how these tests are interpreted. The age and sex of the athlete, the sport being played, and other medical comorbidities have all been shown to impact the results of these exams. In an attempt to curtail these variations, a baseline exam can be given at the start of the season, which has been shown to improve accuracy in the post-concussion setting. Not all of the exams have perfect test-retest reliabilities though, with more frequent testing leading to improved scores. Balance testing, both on its own and incorporated with other tests, has been used over the past decade in an attempt to reduce some of the limitations found with earlier sideline-based concussion screening. Balance testing is quick, simple, and has good intra-observer reliability.

Disadvantages of this assessment include poor inter-observer reliability and the fact that results typically return to baseline 3 days after a concussion. It is therefore ineffective for intermediate to long term monitoring. Additionally, King-Devick Testing and Vestibular Ocular Motor Screening (VOMS) evaluations, which seek to detect the vestibular impairment found in concussed individuals are becoming increasingly used. Looking towards the future, technology-based balance testing such as the Sensory Organization Test (SOT) has shown improved objectivity and the ability to detect differences in concussed individuals up to 30 days post-injury. However, at present, this technology is too expensive and impractical for initial evaluation, especially at lower levels of competition. Nevertheless, as the price decreases and availability increases, there may be a potential role for it in sideline concussion evaluations.

TREATMENT

Once a concussion is suspected based on the sideline examination, the most important treatment to reduce risk to the injured athlete is to remove him or her from play. Premature return to play presents a multitude of risks for the athlete, including increased risk of brain injury, decreased neurologic recovery and decreased injury threshold for a second concussive event. In rat models, premature exertional activity led to an increase in neuronal cell death and decreased the overall neurologic recovery.22Longhi et al. was able to demonstrate, in a mouse model, severe cognitive impairment if a second concussive event happened within 5 days of the first one, but not if it happened at day 7. They also showed a lower concussive threshold present at day 5 compared to day 7.37This increased risk is similar to that seen in human studies. NCAA Division I football players who sustain a concussion in-season have a 6.5% of sustaining a second one later that season. Of those players, 75% will have their second concussion within 7 days of their first.24The high risks to the athlete of prematurely returning to play emphasize the importance of accurately assessing complete resolution of concussive effects and return of normal brain homeostasis.

Additionally, a close follow-up with a medical provider should be established. The need for a physician to be able to accurately assess and determine when all the concussive effects have dissipated has led to the development and implementation of neurocognitive testing for athletes at many levels. The use of these tests has allowed physicians and training staff to better detect any variations in normal cognition that may not be present on a standard physical exam. These tests depend on the establishment of pre-season baselines with post injury examinations to determine deviations from the baseline.49Multiple neurocognitive tests are currently available in the United States. Studies examining their efficacy have found them to have not only excellent specificity and sensitivity, but also outstanding test-retest reliability.

One of the most common questions encountered while following an athlete with a concussion is how long until he or she can return to play. Historically, return to play has been permitted after the resolution of subjective symptoms (i.e. headache, dizziness etc.).26This paradigm has begun to shift as increased understanding of the neurocognitive effects of concussions has allowed recognition that resolution of symptoms does not mean return to normal brain homeostasis.7In order to reduce the chance of an athlete returning to play while experiencing post concussive effects, the NCAA has adopted a stepwise return to play progression.15 Following the return of baseline neurocognitive exams, the athlete then

begins a 6 step return to play process, beginning with light aerobic activity and ending with step 5 full contact practice, and step 6 return to play. (Figure 1) If at any point during this process the athlete has a return of symptoms or a decrease in neurocognitive testing, they immediately return to the previous step. Ultimately, even with uneventful progression through the first 5 stages, the decision to permit return to play rests with the team physician.

PREVENTION

Appropriate diagnosis and management of sports-related concussions are not the only ways to reduce the morbidity related to these injuries. The other aspect of decreasing adverse effects is through prevention of these injuries altogether. The heightened awareness and media coverage regarding these injuries has led to all 50 states passing some version of a return to play law for youth sports. Despite these legal statutes, a 2012 study of high school athletes in Washington showed that 40% of athletes with concussions stated that they participated in games while experiencing symptoms.47In the 2011 season, following the institution of the NCAA's new concussion policies, the incidence at 3 football programs was seen to double from the prior year.

While legal regulations are necessary, they alone will not change the culture of the coaches and players. Until this happens, large decreases in concussion rates will not be seen. Recent studies examining how changes in this culture could impact concussion rates have shown potential. In 2012, USA Football instituted the Heads Up Football (HUF) educational program, which includes training on proper equipment fitting, proper tackling technique, strategies for reducing player-to-player contact, concussion awareness, heat illness awareness, and sudden death information. The initiation of this program led to a 37% decrease in total head impacts over the course of the season.30Another study looking at alterations in type of practice showed that by limiting contact practices to once per week, head impacts per season could be reduced by 18%.

Additional preventative measures focus on increased utilization and development of improved protective equipment. The use of protective headgear, specifically helmets, has been extensively studied, and shown to be beneficial in many sports. Sulheim et al. performed a study on alpine skiers and snowboarders and found that wearing a helmet reduced your chance of sustaining a concussion by approximately 60%.51 Among football players, substantial research has gone into improving helmet design to decrease concussion incidence.

Current helmets now have laminar shock absorbers with differential impact response. Impact testing has shown that these new helmets result in lower energy transfer then previous models. Additionally, clinical studies have shown up to a 31% decrease in concussions among youth football players wearing these helmets as opposed to older models.13Despite this progress, there is recognition that further advancements are still needed. Prototype models have recently been released with a new technology that allows deformation of the external shell, similar to a car bumper, which may further decrease energy transfer to the cranium. The use of mouth guards has also been investigated for its role in helping prevent sports related concussions. While the use of mouth guards continues to be highly recommended for its role in preventing dental injuries, no studies have been able to show any reduction in risk of concussion associated with their use.

LONG TERM OUTCOMES

The signs and symptoms of concussion may be subtle, and the increased recognition of this fact has led to an increasing number of diagnoses over the last five years.48Despite this upsurge, many experts still believe that concussions are underdiagnosed.8A recent study looking at the incidence of concussions in high school athletes in 2012 showed a rate of .51 per 1000 athletic exposures (AE), which increased to .94 per 1000 AE in football. This large burden of disease has led to increasing concern over what the long term implications might be. For most athletes, symptoms typically resolve within ten days. However, in about 10% of individuals, symptoms will last longer. In a small subset of this group, symptoms will last greater than three months, a condition classified as Post-Concussion Syndrome (PCS).2In 20% of patients with PCS, symptoms will be permanent.

Another long term pathology seen in a small subset of athletes is Chronic Traumatic Encephalopathy (CTE). CTE is a condition characterized by progressive neurologic deterioration and can be diagnosed only via histologic evaluation of the brain that is only possible after death. It is thought that CTE may be related to repetitive mild traumatic brain injury.41Despite popular perception to the contrary, no cause and effect relationship has ever been established between CTE and participation in contact sports or a history of concussion. At most, the literature has only shown a weak association between concussion history and the development of CTE.39When studying CTE, one of the greatest difficulties is establishing a diagnosis. While a patient's history, clinical examination, and imaging findings may be suggestive of CTE, the diagnosis can

only be confirmed post-mortem through a pathologic examination of the brain.23,39 Additional confusion stems from the fact that while certain characteristic brain lesions have been seen in patients with CTE diagnosed post mortem, these changes have also been seen in autopsy examination of multiple patients who were asymptomatic at the time of death.14,41With this lack of clear diagnostic criteria for CTE, identification of risk factors or possible prevention strategies remains difficult. Current guidelines recommend athletes be counseled on the potential risk of CTE, the uncertain state of current scientific knowledge, and the importance of adhering to established treatment protocols following a concussion.

The recent concern about the potential long term consequences of concussions has led to an influx of research, especially studying the more subtle functional and cognitive changes that may occur after a concussion. A study of almost 9000 high school and college athletes showed a strong association between increasing numbers of concussions and neurocognitive symptoms on preseason exam. Significantly increased rates of sleeplessness, dizziness, depression, and irritability were all reported. Additionally, a survey of 1044 former NFL players showed a correlation between a number of concussions and risk of depression, with a 9 fold increase seen between those with zero concussions and those with more than 10. Post-concussive functional impairment has also been demonstrated.

A study of Major League Baseball (MLB) players returning from the disabled list for concussions showed that at two weeks they had worse comparative batting average, on-base percentage and slugging percentage then a matched group returning from bereavement or paternity leave, suggesting that resolution of symptoms does not necessarily mean return to normal function.55 It is important to note, though, that despite most studies showing a relationship between increasing number of concussions and decreasing neurocognitive performance, not all have supported this finding. A 2014 study of 226 potential NFL draft picks showed no correlation between concussion history and Wonderlic or ImPACT scores, seeming to imply that neurocognitive performance is not impacted in all players with a concussion history.

Table 1: NCAA Return to Play Guidelines

Rehabilitation stage	Functional exercise at each stage of rehabilitation	Objective of each stage
1. No activity	Symptom limited physical and cognitive rest	Recovery
2. Light aerobic activity	Walking, swimming or stationary cycling keeping intensity <70% maximum permitted heart rate. No resistance training	Increase heart rate
3. Sport-specific exercise	Skating drills in ice hockey, running drills in soccer. No head impact activities	Add movement
4. Non-contact training drills	Progression to more complex training drills, eg, passing drills in football and ice hockey May start progressive resistance training	Exercise coordination and cognitive load
5. Full-contact practice	Following medical clearance participate in normal training activities	Restore confidence and assess functional skills by coaching staff
6. Return to play	Normal game play	

CONCLUSION

Multiple epidemiologic studies have shown a high incidence of sports-related concussions at all ages with the true rate likely being even higher than reported. The substantial numbers of affected individuals, along with an increased understanding of the short and long term consequences of concussion, demonstrate the high burden of disease from these events. Physicians, athletic trainers, coaches, and parents need to be aware of the signs and symptoms of concussions. They should be educated to remove any athlete with a possible concussion from play immediately, in order to prevent Second Impact Syndrome and further cognitive insult. There is also an increasing amount of literature to suggest that simply allowing return to play when the athlete is no longer symptomatic is not appropriate as they often continue to have subtle cognitive changes. Instead, utilization of neurocognitive testing should be employed to certify a true return to baseline prior to allowing return to play. Despite the recent surge in concussion-related literature, there remain many unknown factors. Specifically, additional research is still required in order to better define long term consequences as well as identify whether a relationship exists between concussions and Chronic Traumatic Encephalopathy. This is a critical area of research and one that should be highly supported and followed closely by all sports medicine practitioners.

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POTRESI MOZGA U SPORTU: DOPUNA DIJAGNOZE, TRETMANA I POSTUPANJA (OTVORENO ISTRAŽIVANJE)

Kontekst: Potresi mozga predstavljaju drugi najveći izvor obolijevanja vezanog za sport, odmah iza uganuća i dilatacija. Kako su potencijalne razorne posljedice ovih povreda bolje objašnjene, tako je jako važno da doktori specijaliste sportske medicine razumiju kako pravilno postupati u slučaju potresa mozga kod sportista. Ovaj rad razmatra najnovije podatke o našem razumijevanju patofiziologije ovog kompleksnog procesa, zajedno sa trenutnim preporukama po pitanju dijagnoze, tretmana i postupanja. Prikupljanje dokaza: U aktuelnoj literaturi su razmatrani članci o patofiziologiji, dijagnozi, tretmanu i postupanju u slučaju potresa mozga. Dizajn istraživanja: Sistematički pregled Nivo dokaza: IV Rezultati: Potresi mozga su jedan od najvećih uzroka obolijevanja vezanog za sport na svim nivoima natjecanja. Skorašnja istraživanja su povećala naše razumijevanje patofiziologije ovog stanja i poboljšala našu sposobnost dijagnosticiranja i tretmana.
Zaključak: Značajan broj sportista koji zadobiju potres mozga svake godine u kombinaciji sa potencijalno razornim kratkoročnim i dugoročnim posljedicama potresa mozga stvaraju znatan teret bolesti. Kako bi povećali kliničke ishode pacijenata i smanjili oboljenja, treneri, sportski treneri i doktori moraju znati kako na odgovarajući način dijagnosticirati i postupati sa sportistom koji je doživio potres mozga. Cilj ovog rada jeste predstaviti trenutne najbolje prakse za dijagnozu, tretman i postupanje u slučaju potresa mozga, zajedno sa aktuelnim razumijevanjem kompleksnih neurofizioloških promjena koje se dešavaju.

Ključne riječi: Potres mozga, traumatska ozljeda mozga, sportska medicina, povratak u punu aktivnost i hronična traumatska encefalopatija.

Received: March 27, 2017 / Accepted: April 15, 2017
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HEART FREQUENCY AND LACTATE CONCENTRATION IN BLOOD WITH KARATE ATHLETES, DURING THE SIMULATED AND OFFICIAL COMPETITIONS

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ABSTRACT

A research has been conducted on a sample of 29 representatives – male extracted from the Karate population, a potential representative from the adult categories of younger seniors (U21) and seniors of the Republic of Macedonia. The main purpose of the research is to determine the changes that occur in cardiac frequency and blood lactate levels in senior karate athletes. For the realization of the research and monitoring of the heart rate in this research, the latest technology of the Polar Team App was used, which was specially designed for the use and monitoring of exercise processes in indoor sports (hall). A portable Scout + Lactate analyser device was used to determine the amount of lactates in the blood. During the simulated matches, the obtained mean values of the heart rate (134.69 HRavg to 147.41 HRavg) are lower than those obtained during the official matches with a value of (175.77 HRavg). As for the height of the lactates, high variability in response to lactates in the blood was determined, showing a different anaerobic glycolytic contribution. To determine the differences between the two measurements, a T-test for small dependent samples was applied.

Keywords: cardiac frequency, blood lactate, karate athlete

INTRODUCTION

In today's science, we are witnessing that sports that are often analysed by researchers include athletic disciplines (running, biking, and swimming), probably because these athletes can be easily assessed using standard, laboratory and field tests (Francescato et al., 1995). In the last two to three decades, there have been a growing number of published publications and scientific research on karate sports. The development of modern karate is associated with a growing presence of science, whose research results have been largely used in the training processes of karate (Korpanovski, at all 2007). All these research contributed to building the scientific basis in this sport. In terms of its structural complexity, karate belongs to poly-structural acyclic sports. Karate as a poly-structural acyclic sport, which is dominated by acyclic unpredictable movements, has only a symbolic destruction of the opponent. This positive destruction, the karate athlete seeks to give by making controlled strokes to the opponent's head and body, although the movements are a combination of maximum and sub maximal intensity. It is precisely such symbolism that gives a special place and importance to this sport. As a sport and martial art, karate encourages self-discipline and develops concentration and awareness. (Kostovski et al., 2014). Traditional karate trainings in their training program include basic techniques, kata, and sparring activities (Imamura, 1998). The competitions organized by the World Karate Federation (WKF), in modern karate, consist of two equally important disciplines, sports fighting (kumite) and form (kata) (Korpanovski et al., 2011; Taben et al., 2013). The Kumite discipline is increasingly attracting attention of a large number of researchers, scientists, trainers

and interns who daily explore this area. The Kumite is a synonym for karate combat and consists of carrying out freely chosen defensive and offensive techniques, which are applied in relation to the opponent (Imamura, 2002). In principle, the kumite consists of an outburst of successive techniques, separated by occasional movements (hopping), which enable rapid changes in the position of the body (Iide, 2008).

METHODS

In order to determine the changes that occur in cardiac frequency and blood lactate levels in karate athletes - seniors, a sample of 29 male examinees were extracted from the karate population, potential representatives from the adult categories of younger seniors (U21) and seniors from Republic of Macedonia. Athletes who were treated in the sample were competitors who participated in the state championship and three prime leagues organized by the World Karate Federation WKF (World Karate Federation). The survey was conducted during official competitions. In order to carry out the research and monitoring of the heart rate in this research, the latest technology of Polar Team App was used, which is specially designed for the use and monitoring of training processes in indoor sports (hall). For this purpose, H7 sensors for registering the speed of heart rate were used. The H7 sensor is compatible with Bluetooth smart ready devices that support the performance of the heart rate sensor and record the beats and changes that occur each second. To determine the level of lactates in the blood, upon prior written consent from each participant, medical laboratory technicians take samples from the bloodstream, each time from another finger. A portable Scout + Lactate analyser was used to determine the amount of lactates in the blood, and its validity was confirmed in previous studies. Blood lactate levels during training or simulated matches were analysed under conditions very similar to the actual ones for the disciplines. Lactates were taken after the completion of any simulated and official fight. In total, blood lactates were taken at 6 mark points during simulated and official fights. To determine the differences between the two measurements, a T-test for small dependent samples was applied.

RESULTS AND DISCUSSION

In order to determine whether there are statistically significant differences in the variables, the heart rate frequency and concentration of lactates in the blood obtained in the simulated training matches and the results obtained at the official competition, a T-test for small dependent samples was applied. The results of the test are shown in Table 1. From the overview of table no. 1, it can be seen that statistically significant differences are found among the variables of HR3, HR4 and HR5 heart rate, measured in separate training phases, and the HR variable, measured at an official competition. From the values of the arithmetic mean, it can be seen that the value of the heart rate measured at an official match is much higher than the ones obtained in the separate stages of the second training. Statistically significant differences were also found in the variables: concentration of lactates in blood L2, L3 and L4, measured in partial training phases and lactate concentration (L), measured at the official competition. From the overview of the arithmetic mean, it can be seen that the concentration of lactates in a competition is much higher in relation to the concentration of lactates obtained during simulated matches. During the simulated matches, the obtained mean values of the heart rate (134.69 HRavg to 147.41 HRavg) are lower than those obtained during the official matches with a value of (175.77 HRavg). Hence, it can be said that the simulated matches generate lower cardiac reactions than those of the official competitions. Karate fight (Kumite) is an event that imposes high cardiovascular stress on participants, regardless of sex and type of competition, (official or simulated). For comparison, from previous research by Chaabène et al. (2012), they found that during an official karate competition, cardiovascular reactions reached 91% ± 5% of HR max (177 ± 14 bpm) and that elite karate athletes spend 65% of the time with exercise HR> 90% of the individual maximum cardiac frequency. If we compare this simulated survey with official competitions (91.70% from official and 91.14% of the HR max from simulated), it will be noted that there are many similar endpoints related to the heart rate that has been achieved during official competitions and also lower values achieved during simulated matches. Additionally, data on HR values during simulated competitions in the Kumite disciplines ranged from 92 ± 2%, HRmax according to the research of Doria et al. (2009), and 92.7% -100.9% of HRmax according to the research of Zehri Sale (1997). According to Sandra V. (2015), the average heart rate values during simulated karate fights were moving from 95% of the maximum HR for all three fights. The acquired values are confirmed in several studies, that is, in the discipline Kumite, it requires very high almost maximal cardiovascular reactions. Tabben (2013), established the values of HR max obtained during an international karate competition, which were 183 ± 8-strokes per minute, corresponding to approximately 91 ± 3% of HR max. This suggests that very high requirements are placed on aerobic metabolism during the official competition. Comparable cardiovascular reactions have been

Table 1: NCAA Return to Play Guidelines

	Training		Match				
	Mean	**Std. dev**	**Mean**	**Std. dev**	**T-test**	**df**	**p**
HR3	134.69	18.33	175.77	11.49	-9.22	49.00	0.00
HR4	141.72	27.07	175.77	11.49	-5.52	49.00	0.00
HR5	147.41	21.46	175.77	11.49	-5.61	49.00	0.00
L2	6.52	2.61	11.75	1.68	-4.57	49.00	0.00
L3	8.26	3.26	11.75	1.68	-3.68	49.00	0.00
L4	8.89	3.34	11.75	1.68	-21.01	49.00	0.00

reported by Casolino H (2012) (93% HR max) during simulated karate sparring competitions and Imamura H (1997), (94% HR max) in similar research in Taekwondo, at the international level (93%) Kenney W, (2012). This suggests that the physiological needs of sports even resembling karate are similar. Heart rate HR, in simulated fights, has lower values, unlike the official, but both are performed in high energy zones. As for the height of the lactate, high variability in response to lactate in the blood was determined, showing a different anaerobic glycolytic contribution. SandraV, (2015), in her survey, obtained average lactate values in simulated karate fights (6.11 ± 2.03 mmol / l), which are somewhat lower than the values obtained in other studies in simulated karate fights, which were conducted by Beneke et al. (2004), Doria et al. (2009), Tabben et al. (2014), Chaabène et al. (2014). In these studies, an average value of about 7 mmol / L was found in a simulated fight and about 11 mmol / L in official competitions. In fact, these are the data from the only studies that compare simulated and official fights, where we have shown a significantly higher value of lactates in the blood after official competitions, compared to simulated, which shows that the glycolytic participation is higher during official competitions. The values obtained in the study are ranging from 8.26 mmol / L to 8.89 mmol / L, and have a statistical significance of p =.00

CONCLUSION

Based on the analysis of the results obtained from the functional reactions, which occur in karate athletes with the burden in simulated and official karate competitions on a national and international level, conclusions are found in the following directions: international karate competitions have a high intensity of activity, which causes approximately maximum cardiovascular reactions and high lactation concentrations. In addition, the changes that occurred did not differ and there were more different results achieved in all the matches during the competition. One of the most important factors in high intensity occasional exercises such as karate fighting, whether it's simulated or official, is the aerobic readiness of the athlete. And according to Beneke, R (2004), this ability is associated with the process of a faster recovery after increased activity intensity in each fight, as well as after each match. Hence, the conclusion is that, in the training process, this important aspect should be taken into account and that the aerobic high readiness of athletes is an important factor in the recovery of athletes, for which we now already have confirmation from additional research.

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OTKUCAJI SRCA I KONCENTRACIJA LAKTATA U KRVI KOD KARATISTA TOKOM SIMULIRANIH I ZVANIČNIH TAKMIČENJA

Istraživanje je provedeno na uzorku od 29 predstavnika - muškaraca koji se bave karateom, potencijalnim predstavnikom kategorije odraslih mlađih seniora (U21) i seniora Republike Makedonije. Glavna svrha istraživanja jeste utvrditi promjene koje se dešavaju u frekvenciji srca i nivou laktata u krvi kod karatista - seniora. Za provođenje istraživanja i praćenje otkucaja srca, u ovom istraživanju se koristila najnovija tehnologija PolarTeamApp koja je posebno kreirana za primjenu i praćenje procesa obavljanja vježbi u zatvorenim sportskim dvoranama. Prenosivi Scout + Lactate uređaj za analizu se koristio kako bi se utvrdila količina laktata u krvi. Tokom simuliranih takmičenja, dobivene su srednje vrijednosti otkucaja srca (134,69 HRavg to 147,41 HRavg) koje su niže od onih dobivenih tokom zvaničnih takmičenja u vrijednosti od (175,77 HRavg). Kada je u pitanju nivo laktata, otkrivena je visoka varijabilnost kao odgovor na laktate u krvi, koja pokazuje različit anaerobni glikolitički udio. Kako bi se utvrdila razlika između ova dva mjerenja, primijenio se T-test za male zavisne uzorke.

Ključne riječi: frekvencija srca, laktat u krvi, karatisti.

Received: June 1, 2017 / Accepted: June 15, 2017
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CAN EIGHT WEEKS OF STABILIZATION EXERCISE CHANGE THE AMOUNT OF PEAK VERTICAL GROUND REACTION FORCES DURING SINGLE LEG DROP LANDING?

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ABSTRACT

The purpose of this study was to investigate the kinetics during single leg drop landing test following a CST intervention. The present research was a quasi-experimental study with pretest/posttest and a control group. After giving their informed written consent, 30 athletes (15 in the experimental group, and 15 in the control group) volunteered to participate in the training program consisting of CST sessions, 3 times per week for 8 weeks. The training group performed the CST during 8 weeks, but the control group did not perform these exercises. Kinetic variables in pretest and posttest during single-leg drop landing were measured by motion analysis and a force plate device. Data were analysed using mixed ANOVA repeated measure significance level of $P < 0.05$. The results revealed that the peak vertical ground reaction forces, loading rate, and average loading rate significantly reduced following an 8 weeks CST intervention ($P<0.05$). This study shows evidence that core stability training improves landing kinetics, and may reduce lower extremity injury risk in athletes.

Keywords: Core stabilization training, Drop landing, Ground reaction forces

INTRODUCTION

Core stability refers to muscle control of the lumbo-pelvic surrounding area aimed at maintaining functional stability in neutral positions and assisting in the production and transmission of energy from the trunk to the limbs (Akuthota & Nadler, 2004; Shirey et al., 2012). Although core stability exercises are widely used in injury prevention and rehabilitation, recently it is used more as a way to enhance athletic performance (Akuthota & Nadler, 2004). Training and numerous sports activities involve landing and need appropriate jump-landing technique (Yeow, Lee, & Goh, 2010). Landing is a dynamic movement which is often used to identify biomechanical properties attributed to the increased risk of injury in athletes (Ford, Myer, Schmitt, Uhl, & Hewett, 2011). High vertical reaction forces created in a short period (high impulse) during landing practice are associated with increased risk of injury (Olsen, Myklebust, Engebretsen, & Bahr, 2004). These forces that are exerted on the lower limbs may cause more damage (Bates, Ford, Myer, & Hewett, 2013). This mechanical impact must be reduced through the musculoskeletal system (Wu, Liang, Lin, Chen, & Hsu, 2009). One of the most important factors involved in the injuries is the forces exerted on the joints of the lower limb (McNair, Prapavessis, & Callender, 2000). The increasing influence of the loading implies poor shock absorption and imposing a high level of pressure on the lower limb in a short period of time (Hargrave, Carcia, Gansneder, & Shultz, 2003). The ability to control and appropriate absorption of the forces during dynamic activities can reduce the damage; therefore, understanding the factors affecting the body's ability to absorb these forces might be effective in preventing lower extremity injuries and improving the biomechanical performances (Hargrave et al., 2003). Evidence shows

that core muscle training is effective in reducing ground reaction forces. Araujo et al. (2015) stated that core stability training would reduce the vertical reaction force and improve the landing kinetics and might reduce the risk of lower extremity injuries in female athletes (Araujo, Cohen, & Hayes, 2015). Dynamic stability of the trunk and lower extremity is based on the neuromuscular control of lumbar-pelvic-hip complex (Oliver, Stone, Wyman, & Blazquez, 2012). Core muscle training improves the stability and endurance capacity of the core muscles (Imai et al., 2010) which could explain performance improvement and also the forces acting on the body during endurance activities (Sato & Mokha, 2009). The association between poor stability of the core body and injuries has been already described (Darin T Leetun, Mary Lloyd Ireland, John D Willson, Bryon T Ballantyne, & IRENE MCCLAY Davis, 2004). Particularly, weak neuromuscular control over core muscles may increase knee valgus torque and hip external adduction during the landing (Darin T Leetun et al., 2004), which increase the load on the anterior cruciate ligament (Shin, Chaudhari, & Andriacchi, 2011). Meier et al. (2006) reported that the neuromuscular training program, including balance training and essentially dynamic core stability exercises for trunk and pelvis significantly reduce the contact forces of landing while plyometric exercises do not reduce these forces (Myer, Ford, Brent, & Hewett, 2006). As the evidence suggests, core stability exercises can reduce the maximum landing forces and may also lead to improvement of the performance, but the effectiveness of specific interventions in the trunk and particularly of core stability training is not determined (Araujo et al., 2015). Even though previous studies investigated the landing forces, it is suggested that the core trunk muscles may affect the landing technique, too (Araujo et al., 2015). In this study, the impact of core stability on landing kinetics will be considered. Therefore, this study aims to determine whether the intervention of 8 weeks long core muscle training can improve the kinetics of landing.

METHODS

The current research design was quasi-experimental with pretest-posttest design and the control group. A total of 30 professional basketball athletes, which were selected by convenient and purposeful sampling method, participated in this study. Subjects were randomly assigned in the experimental (n=15) and control groups (n=15). The experimental group and the control group did routine basketball practices. In addition, the experimental group performed 8 weeks of core muscle training, while the control group did not do any special training in this regard. Exclusion criteria included a history of cardiovascular or nervous disease over the past year, a history of abdominal injury, lower back or limb pain in the past year, limitation of physical activity or surgery in the last two years, untreated injuries or pain in the spine, abdomen or lower extremity limb, or the absence from more than two sessions during the exercise protocol. All tests were conducted in the Ergonomics Laboratory of Musculoskeletal Disorders Research Center, Faculty of Rehabilitation, Isfahan University of Medical Sciences. Before participation, the test and training protocols were explained to the subjects and they all signed the consent form. A Force Plate (Kistler Model, 5×60×50 cm, Switzerland) was used to measure the initial contact of the foot on the ground, peak vertical ground reaction forces, loading rate, and the average loading rate. The loading rate is the amount of force during landing and is a measure of the pressure on the tissues. This variable is defined as the maximum reaction force when a person hits the ground until it reaches the peak force. But the average load is the peak reaction force minus the reaction force at the moment of contact, where the ground divided by the time between these two forces and the average amount of load should be less than the amount of the load. Information regarding ground reaction forces was recorded using a force plate with the sampling frequency of 200 Hz (Gribble, Mitterholzer, & Myers, 2012). After some orientation, the subjects were invited to the laboratory to evaluate the pre-intervention (first week) landing performance and measure height, body weight and the reaction force. Eight weeks later, the same procedure was repeated after completing the intervention. After standard warm-up, subjects performed 3 tests of landing barefoot from a wooden box with a height of 40 c m (Hubbard, Kramer, Denegar, & Hertel, 2007). The peak landing force is defined as the most vertical ground reaction force observed following the landing from the box (Araujo et al., 2015). Before the test, participants practiced landing 3 times. Three successful trials were recorded for each subject.

Test results taken from the participants were converted to a 3D file using Qualisys Track Manager (Qualysis motion capture systems, Sweden 2.7 (build 771)) and then an output file using Mokka as an ASCI file (3D Motion kinematic and kinetic analyser, version 0.6.2) in order to determine ground reaction forces. Next, the mean data from 3 successful landings was used to calculate variables. The relative maximum landing force was calculated by dividing the vertical reaction force of peak landing (N) by the subject's body weight (NBW). The amount of load was obtained in the form of a normalized peak vertical force divided by the time it reached the maximum force from the moment the subject's leg made first contact with the ground (Eq. 1) (Zhang, Bates, & Dufek, 2000). The average load volume was calculated through Equation 2 (Araujo et al., 2015)

$$Loading\ rate = \left[\frac{peak F_z(N) / body\ weight\ (N)}{Time\ to\ peak\ F_z}\right] = \frac{BW}{ms}$$

Equation 1: Loading rate

$$\text{Average loading rate} = \frac{peak\ VGRF - VGRF\ at\ first\ foot\ contact}{time\ interval}$$

Equation 2: Average loading rate

Subjects of the experimental group conducted core muscle exercises 3 times a week for 8 weeks. Experimental and control groups were allowed to carry out their normal activities. All training sessions were supervised by the researcher who attended all practice sessions to ensure that the subjects were performing the exercises correctly. Each subject participated in three training sessions every week. The subjects of the experimental group had to attend at least 21 out of 24 training sessions and they were not allowed to be absent for 3 consecutive training sessions, otherwise, they were excluded from the study. At the beginning of each training session, general warm up exercises (including jogging, warm up exercises for upper extremity, body, and lower extremities) were conducted for 5 minutes (Araujo et al., 2015). All data analyses were performed using SPSS 22. To examine data distribution in two groups, Shapiro-Wilk test was used. Also, mixed ANOVA repeated measure test was used to compare the relative peak landing, the average load amount, and anterior shear force. The hypothesis testing was also conducted at the significance level of 95% and $\alpha \leq 0.05$.

RESULTS

Significant differences were not observed between subjects in their demographic data which included age, weight, and height (Table 1). The peak relative reaction force in the experimental group decreased 0.64 N•NBW and after participating in stabilization training 0.02 N•NBW in the control group (Table 2). Mixed ANOVA repeated measures test results showed significant differences between pretest and posttest results; furthermore, the results showed a significant difference between the two groups. Test results also showed that interactive effects of time (pre-intervention and post-intervention) on the groups (experimental and control) are significant. Mixed ANOVA repeated measures test results on the amount of load variable and the average amount of load showed significant differences between pretest and posttest. Furthermore, no significant difference was found between the two groups. The results also showed that interactive effects of time on the groups were significant.

Table 1. Demographic information of subjects (Mean ± SD) pertaining to the studied groups

	Experimental group	**Control group**	**t**	**p**
Age (year)	61.6±0.9	61.8±0.7	0.344	0.79
Height (cm)	185.25±3.4	186.45±4.3	0.743	0.48
Weight (kg)	69.5±6.3	70.2±5.3	0.870	0.43

Table 2: Analysis of variance with repeated measures for study variables

Variable	**Group**	**Pre-Intervention**	**Post-Intervention**	**Comparison Within Groups**	**Comparison Between Groups**	**Interaction**
The maximum vertical ground reaction force N/NBW	Experimental	2.55 ± 0.73	1.91 ± 0.57	F = 43.2 P = 0.012*	F = 1.88 P = 0.032*	F = 14.22 P = 0.029*
	Control	2.81 ± 0.63	2.79 ± 0.68	F = 23.54 P = 0.114		
Amount of load N/NBWs	Experimental	207.31 ± 70.31	123.42 ± 45.76	F = 27.42 P = 0.0.03*	F = 4.53 P = 0.03*	F = 15.66 P = 0.031*
	Control	209.56 ± 65.87	207.12 ± 54.42	F = 10.22 P = 0.312		
Average amount of load N/NBWs	Experimental	35.42 ± 12.11	21.17 ± 9.1	F = 17.88 P = 0.038*	F = 3.76 P = 0.04*	F = 19.88 P = 0.036*
	Control	34.64 ± 14.02	33.61 ± 43	F = 7.28 P = 0.23		

* Indicates the statistically significant difference between before and after training period ($p \leq 0$).

DISCUSSION

This study aimed to investigate the effect of 8 weeks long core stabilization training on the kinetics of landing. The results of this study showed significant decrease in the peak reaction force during landing after the training intervention. Studies have shown that muscle contraction before and during the initial ground contact help to spread the load and reduce stress on the joints [35]. This reduction of load amount and the force exerted on the joints needs a strong control of musculoskeletal system [36]. It has been shown that in various landing conditions, the core muscles are alternatively involved in the energy absorption and the forces exerted on the trunk (Okubo, Kaneoka, Shiina, Tatsumura, & Miyakawa, 2013). Iida et al. (2013) reported that the landing training program lasting 2 weeks contributed to a 19% significant reduction of the landing force per kilogram of body weight, in the first phase of landing, compared to 1.4% reduction in the control group (Iida, Kanehisa, Inaba, & Nakazawa, 2013).

Strong and stable lumbo-pelvic region facilitates effective transfer of power from the ground to create movements and/or torque in the limbs (Behm, Leonard, Young, C. Bonsey, & Mackinnon, 2005). When the forces of reaction resulting from limb movement challenge trunk sustainability, some muscles are contracted before limb agonist muscles to compensate for the effects of turbulence on the posture (Comerford & Mottram, 2001). The central nervous system uses different strategies for postural control during the movements. Trunk muscles act by feedforward mode and are activated to reduce the torque created by turbulence before or in a combination with the main organs (Silfies, Mehta, Smith, & Karduna, 2009). Increasing the rigidity of the trunk centre provides proximal stability for upper and lower extremity movements, keeping the centre of gravity at the level of reliance and effective absorption of created distal forces (D. T. Leetun, M. L. Ireland, J. D. Willson, B. T. Ballantyne, & I. M. Davis, 2004).

Previous studies showed preactivation of the lower extremity (Iida, Kanehisa, Inaba, & Nakazawa, 2011) and trunk muscles (Iida et al., 2011) before contacting with the ground during landing. Okubo et al. (2013) mentioned that abdominal muscles are activated before landing (Okubo et al., 2013). Stevens et al., 2007 (2006) investigated the effect of lumbar stabilization exercises on the muscle recruitment patterns in healthy individuals and their results showed increased level of activity in the abdominal muscles. The researchers found that muscle recruitment patterns can be changed in healthy people using a training program that focuses on neuromuscular control. Therefore, in regard to the aforementioned, we conclude that stabilization exercises used in this study improve feedforward muscle activity in this area through increasing core stability that leads to the adoption of a better power absorption strategy.

While we cannot explain the mechanism through which core stability training interventions reduce peak vertical reaction force during a landing jump, previous studies have shown that weak trunk neuromuscular control is accompanied by an increase in valgus, torque and motion in knee adduction (Hewett et al., 2005) and a higher prevalence of lower extremity injuries (Zazulak, Hewett, Reeves, Goldberg, & Cholewicki, 2007) and kinematic changes are accompanied by peak vertical reaction force (Hewett, Lindenfeld, Riccobene, & Noyes, 1999). On the contrary, neuromuscular training, including trunk exercise, decreases knee adduction torques and inclination to valgus fall during landing (Myer et al., 2006).

Trunk muscle activity which has priority over the lower extremity muscles activity and position and movement of the trunk during the landing, have a significant impact on the reaction force (Kulas, Schmitz, Shultz, Henning, & Perrin, 2006). Iida et al. (2011) reported that contact force has a positive relationship with maximum voluntary contraction of rectus abdominis. (Iida et al., 2013). Based on previous evidence, a reduction in the peak landing force observed in the present intervention can reduce the risk of knee injury (Myer et al., 2006). Peak vertical reaction force has a strong association with the knee adduction and abduction torques (Hewett et al., 1999).

CONCLUSION

The results of the current study showed that core muscle training, which is an isometric trunk exercise, may be an important component in prevention programs of lower extremity injuries and may contribute to the kinetics of professional landing, which were seen in previous multi-components programs. Previous evidence has shown that the landing kinetics is associated with ACL load (Hewett et al., 2005). These changes may imply a prevention readiness programs plan for non-impact ACL injuries in athletes.

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MOŽE LI OSAM SEDMICA VJEŽBI STABILIZACIJE PROMIJENITI MAKSIMALNU VERTIKALNU SNAGU REAKCIJE PRILIKOM DOSKOKA NA JEDNU NOGU?

Svrha ovog istraživanja je ispitati kinetiku prilikom doskoka na jednu nogu nakon treninga stabilizacije trupa (engl. CST - CoreStabilityTraining: trening stabilizacije trupa). Istraživanje je kvazieksperimentalno sa predtestiranjem/posttestiranjem i kontrolnom grupom. Nakon pismenog pristanka, 30 sportista (15 u eksperimentalnoj i 15 u kontrolnoj grupi) se dobrovoljno javilo za učešće u programu treninga koji se sastoji od CST sesija, a koje se obavljaju 3 puta sedmično u periodu od 8 sedmica. Grupa koja je vršila treninge je tokom 8 sedmica prolazila kroz CST, dok kontrolna grupa nije učestvovala u ovim vježbama. Kinetičke varijable predtestiranja i posttestiranja prilikom doskoka na jednu nogu su mjerene analizom pokreta i putem platforme za mjerenje sile. Podaci su analizirani korištenjem mješovite ANOVE za ponovljena mjerenja u nivou značajnosti od $P < 0,05$. Rezultati su otkrili da su maksimalne vertikalne snage reakcije, opterećenje, i prosječno opterećenje značajno umanjeni nakon 8 sedmica CST treninga ($P<0,05$). Ovo istraživanje pruža dokaze da trening stabilizacije trupa poboljšava kinetiku doskoka (prilikom dodira sa tlom), te može smanjiti rizik od povreda donjih ekstremiteta kod sportista.

Ključne riječi: Trening stabilizacije trupa, doskok, snage reakcije u dodiru sa tlom.

Received: April 14, 2017 / Accepted: April 21, 2017

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ANALYSING PARTIAL QUANTITATIVE CHANGES OF THE APPLIED KEY MOTOR VARIABLES AND VARIABLES FOR THE ESTIMATION OF MOTION STURCTURES IN FOOTBALL AND HANDBALL

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ABSTRACT

In order to determine the partial quantitative difference (partial results of quantitative changes) for changes occurring in tests evaluating 18 motor skills that were researched and 8 tests for evaluating the motion structures in handball and football, in both groups of studied subjects (control and experimental), a univariate level test – T-test for paired samples was applied. The study was conducted on a sample of 140 male high school students, divided into two sub-samples (control and experimental group) consisting of 70 students each. The control group was included in the regular physical education curriculum lasting two hours per week, while the experimental group, in addition to the regular two hours, had two more hours of physical education with the use of handball and football motion structures for the period of one school term. The results showed that in order to determine the partial quantitative changes (partial success quantitative changes), the T-test for paired samples at the beginning and at the end of the scheduled measurements indicates that there were significant partial quantitative changes in the variables of the studied motor space. In order to determine the partial quantitative changes (partial success quantitative changes), especially for changes in the tests for assessing and monitoring the movement structures of handball and football, the T-test for paired samples at the beginning and at the end of the scheduled measurements indicates that there have been no significant partial quantitative changes in variables for assessing and monitoring the area of handball and football motion structures.

Keywords: motor skills, movement structures, T-test, students, football, handball.

INTRODUCTION

The basic concept for the improvement of the students' motor skills, that is, development of motor skills, and thus the basis for their motor behaviour to a variety of stimuli, in the appropriate modality, volume, intensity and frequency of the operating time, for 12 to 17-year-olds (Bala, 1986). This is only possible for those who train sports, but not in the classic physical education in elementary and secondary schools. In this way, motor development in the sensitive period of adolescence should be raised to a higher level, so as to make it last longer, while making the process of development and decline of these abilities slower. All this clearly indicates that physical education for high school students must raise the level of sports training, taking into account the motor, rather than the chronological age of the students, which should result in their better and richer motor and specific motor maturation. In some motor skills, genetic factors play a bigger role (importance), in others

less, but in all the cases there is a possibility of a certain influence on their development through specific training methods. Basic motor skills are the basis of every movement learning task pertaining to a particular technique, but they can be considered as a representation of a fundamental value in the overall area of human motor functions. Among the researchers who deal with the problem of identification and measurement of motor skills, there are significant differences, both in terms of the number of these capabilities, as well as in terms of their anthropological meaning. One of these differences is the result of a trivial semantic disagreement, however, most are the consequences of different approaches to research in which the aim was to identify the primary motor skills. The main objective of the research is to determine the partial quantitative changes of applied motor and key variables for assessing motion structures of handball and football.

RESEARCH METHODOLOGY

This research has a longitudinal character with a view to the time period of six months and the influence of a regular, programmed and specially designed teaching of physical and health education in high school.

The sample

The selection of the sample is determined by the number of students enrolled in the first and second years of secondary school. The study included a sample of 140 students, divided into two sub-samples, with 70 students being in the experimental, and another 70 in the control group I and II. The above mentioned students are 15-17 years old.

The sample of variables

The measuring instrument for this research was made in the form of a student card with general data and a test battery consisting of 18 variables for the assessment of motor abilities and eight variables for the assessment of motor skills regarding handball movement structures (4 variables) and football motion structures (4 variables) (Mikić, 1999).

Methods of data processing

The characteristics and size of the selected sample of individuals, especially the goal set and research preferences, determined the basic methods for processing the results of research. The data from this study were processed using software packages for univariate and multivariate data analysis. The analysis was done using SPSS 6.0 and SPSS 12.0, for the purpose of testing preferences and providing an adequate response to the subject of the researched problem. Using the univariate T-test for paired samples, samples were tested for differences in the variables before and after the applied program (partial quantitative effects of changes).

THE RESULTS AND DISCUSSION

Analysis of the results obtained for partial quantitative changes (T-test) of the applied key motor variables in the control group

Based on the results of the examined motor variables' arithmetic means in the initial and final control group sample measurements (Table 1), and on the basis of the change (difference) significance tested using the T-test for paired samples (Table 2), it is clear that the applied regular physical education curriculum for students of the 1st and 2nd years of high school produced significant partial quantitative results. Based on the results of arithmetic means in motor variables in the initial and final control group sample measurements (Table 2), and on the basis of the change (difference) significance tested using the T-test for dependent samples (Table 58), it is clear that the applied teaching work programme for the said group produced significant partial quantitative results. When the results of the T-test motor variables (Table 2) showed no statistically significant difference between the initial and final measurements, the final measurement of the control group was given favour. Statistically significant differences were achieved in all the applicable variables except the variable standing high jump (MFESUN). Thus, the results indicate that it was necessary to make corrections in the selection of teaching operators who deal with developing explosive strength (vertical jumping), and apply it to the physical education curriculum to fully justify the goal.

Table 1: Descriptive statistics, T-test

Pair	Mean	N	Std. Deviation	Std. Error Mean
1 MKOS3M - F1	35.0013- 32.3106	70	4.90170- 4.79324	.58587-.57290
2 MKOKUS- F2	11.7890-10.9596	70	1.61304-1.07610	.19279-.12862
3 MAGTUP- F3	29.4144-28.8771	70	2.66975-2.40720	.31910-.28772
4 MPGVCN- F4	12.1286-12.8000	70	3.63924-3.03411	.43497-.36264
5 MPGHCR- F5	22.7000-24.3000	70	4.96174-4.90297	.59304-.58602
6 MPGPIK- F6	30.6000-32.0000	70	13.64179-5.25816	1.63051-1.82370
7 MFLPRK- F7	.8571-.1429	70	6.83827-6.52595	.81733-.78000
8 MFLISK- F8	78.2429-85.0714	70	16.17606-8.11823	1.93341-2.16554
9 MFLPRS- F9	52.6714-58.7429	70	7.47890-5.84259	.89390-.69832
10 MFESDM- F10	158.8857-165.8143	70	28.23378-9.60038	3.37458-3.53792
11 MFEBML- F11	74.5714-79.9571	70	18.17673-8.29028	2.17253-2.18611
12 MFESUN- F12	33.4714-32.6857	70	4.66787-3.88062	.55792-.46382
13 MRCPTL- F13	7.9143-11.0714	70	5.61247-5.79685	.67082-.69286
14 MRCZTL- F14	15.5286-17.3571	70	10.17060-7.88878	1.21562-.94289
15 MRCSKL- F15	9.1857-12.9286	70	4.75575-4.35498	.56842-.52052
16 MBFTAR- F16	28.1286-29.7286	70	2.34008-2.47844	.27969-.29623
17 MBFTAN- F17	18.6571-19.7143	70	1.28408-1.61643	.15348-.19320
18 MBFPTZ- F18	11.1429-12.4286	70	2.52113-2.33791	.30133-.27943

Table 2: The motor variables change (difference) significance in the initial and final control group testing using the T-test

Pair	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
1 MKOS3M - F 1	2.69071	2.63971	.31551	2.06130	3.32013	8.528	69	.000
2 MKOKUS - F 2	.82943	1.47078	.17579	.47873	1.18012	4.718	69	.000
3 MAGTUP – F 3	.53729	1.59771	.19096	.15632	.91825	2.814	69	.006
4 MPGVCN – F 4	-.67143	1.93908	.23176	-1.13379	-.20907	-2.897	69	.005
5 MPGHCR – F 5	-1.60000	1.71439	.20491	-2.00878	-1.19122	-7.808	69	.000
6 MPGPIK - F 6	-1.40000	4.41145	.52727	-2.45187	-.34813	-2.655	69	.010
7 MFLPRK - F 7	.71429	1.37412	.16424	.38664	1.04193	4.349	69	.000
8 MFLISK - F 8	-6.82857	7.19293	.85972	-8.54367	-5.11348	-7.943	69	.000
9 MFLPRS – F 9	-6.07143	8.63817	1.03246	-8.13113	-4.01173	-5.881	69	.000
10 MFESDM – F 10	-6.92857	4.15748	.49691	-7.91989	-5.93725	-13.943	69	.000
11 MFEBML - F 11	-5.38571	8.55891	1.02298	-7.42651	-3.34492	-5.265	69	.000
12 MFESUN – F 12	.78571	5.81575	.69512	-.60100	2.17243	1.130	69	.262
13 MRCPTL – F 13	-3.15714	5.44973	.65137	-4.45659	-1.85770	-4.847	69	.000
14 MRCZTL – F 14	-1.82857	5.18910	.62022	-3.06587	-.59128	-2.948	69	.049
15 MRCSKL – F 15	-3.74286	5.45252	.65170	-5.04297	-2.44275	-5.743	69	.000
16 MBFTAR – F 16	-1.60000	.59952	.07166	-1.74295	-1.45705	-22.329	69	.000
17 MBFTAN – F 17	-1.05714	.81447	.09735	-1.25135	-.86294	-10.860	69	.000
18 MBFPZD – F 18	-1.28571	3.45632	.41311	-2.10985	-.46158	-3.112	69	.003

Analysis of the results obtained for partial quantitative changes (T-test) in the variables used to estimate the handball and football motion structures performed in the control group

After examining the results of arithmetic means in variables used to estimate the handball and football motion structures in the initial and final measurements of the control group sample subjects (Table 3), and on the basis of the change (difference) significance tested using the T-test for dependent samples (Table 4), it is evident that the applied physical education work curriculum for the said group produced significant partial quantitative results.

Table 3: Descriptive statistics, T-test

Pair	Mean	N	Std. Deviation	Std. Error Mean
1 NSNVLSL - F 1	21.8104-21.2921	70	3.85599-3.67816	.46088-.43962
2 NSNHOLZ- F 2	13.0286-14.0571	70	2.81287-2.83296	.33620-.33860
3 NSNSONL- F 3	18.1000-18.9286	70	4.47262-4.46669	.53458-.53387
4 NSNBVPP- F 4	16.0701-14.0153	70	1.74019-1.44116	.20799-.17225
5 RSRBLHZ- F 5	12.1714-12.1060	70	2.21962-1.92918	.26530-.23058
6 RSRULKO- F 6	4.9714-6.2000	70	1.55080-1.37893	.18536-.16481
7 RSRLVSL- F 7	12.7514-12.4371	70	1.71640-1.27652	.20515-.15257
8 RSRILUD- F 8	32.9714-35.7000	70	6.88407-5.54390	.82280-.66262

Table 4: The movement structures change (difference) significance in the initial and final control group testing using the T-test

Pair	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
1 SNVLSL – F 1	.51829	.97720	.11680	.28528	.75129	4.437	69	.000
2 SNHOLZ – F 2	-1.02857	1.08976	.13025	-1.28842	-.76873	-7.897	69	.000
3 SNSONL – F 3	-.82857	1.06283	.12703	-1.08199	-.57515	-6.523	69	.000
4 SNBVPP – F 4	2.05486	2.32995	.27848	1.49930	2.61041	7.379	69	.000
5 SRBLHZ – F 5	.57143	2.30042	.27495	.02291	1.11994	2.078	69	.051
6 SRULKO – F 6	-1.22857	2.03713	.24348	-1.71431	-.74284	-5.046	69	.000
7 SRLVSL – F 7	.61429	2.13428	.25509	.10539	1.12319	2.008	69	.069
8 SRILUD – F 8	-2.72857	8.13281	.97206	-4.66777	-.78937	-2.807	69	.006

In the T-test results (Table 4), statistically significant differences between the initial and final control group measurements were recorded in the final measurement. Almost all the applied variables had statistically significant differences, except the ones used to estimate the handball motion structures, including slalom hand dribbling (SRLVSL) and the variable wall ball drill (SRBLHZ). This means that the applied curriculum for learning and practicing handball movement structures has not fully achieved its goal. In terms of movement structures, the applied football curriculum fully justified its goal.

Analysis of the results obtained for partial quantitative changes (T-test) of the applied key motor variables in the experimental group

By analysing the results of partial quantitative changes with the help of the experimental group basic motor skills T-test for paired samples, and based on the results of arithmetic means in motor variables in the initial and final measurements (Table 5), as well the change (difference) significance tested using the T-test (Table 6), it is clear that the supplemental exercise programme for the above mentioned group produced significant partial quantitative results.

Table 5: Descriptive statistics, T-test

Pair	Mean	N	Std. Deviation	Std. Er. Mean
1 MKOS3M- F 1	32.7610-27.1444	70	6.55911-3.99448	.78396-.47743
2 MKOKUS- F 2	10.6701-9.7909	70	1.07707-.99516	.12873-.11894
3 MAGTUP- F 3	28.2201-26.0369	70	2.68270-1.78111	.32064-.21288
4 MPGVCN- F 4	12.3429-14.3857	70	3.64308-3.71559	.43543-.44410
5 MPGHCR- F 5	23.1143-24.6000	70	5.00881-4.66066	.59867-.55706
6 MPGPIK- F 6	33.2143-34.7429	70	13.09596-13.11342	1.56527-1.56735
7 MFLPRK- F 7	-3.6571-1.1000	70	6.49612-7.45061	.77643-.89052
8 MFLISK- F 8	81.6571-91.6286	70	22.27294-19.43117	2.66212-2.32247
9 MFLPRS- F 9	54.3000-35.4286	70	7.72883-4.90953	.92377-.58680
10 MFESDM- F 10	164.3143-81.9000	70	23.15014-24.81126	2.76697-.58680
11 MFEBML- F 11	73.2571-81.7000	70	17.82986-16.17240	2.13108-.193297
12 MFESUN- F 12	34.5143-38.0000	70	4.66794-5.77350	.55793-.69007
13 MRCPTL- F 13	4.8857-7.8000	70	5.04054-6.57091	.60246-.78537
14 MRCZTL- F 14	22.7143-31.2714	70	16.26514-14.85380	1.94406-1.77537
15 MRCSKL- F 15	9.6857-17.1000	70	4.46092-4.44336	.53318-.53108
16 MBFTAR- F 16	28.4571-32.4286	70	2.89270-3.19225	.34574-.38155
17 MBFTAN- F 17	19.0429-20.9571	70	1.74817-1.71469	.20895-.20494
18 MBFPZD- F 18	11.8714-12.4286	70	2.34627-2.33791	.28043-.27943

Based on the results of arithmetic means in motor variables in the initial and final experimental group sample measurements (Table 5), and on the basis of the change (difference) significance tested using the T-test for dependent samples (Table 6), it is clear that the applied teaching and supplementary work programme for the aforementioned experimental group of subjects produced significant partial quantitative results.

Table 6: The motor variables change (difference) significance in the initial and final experimental group subjects' testing using the T-test

Pair	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
1 MKOS3M – F 1	5.61657	4.99145	.59659	4.42640	6.80674	9.414	69	.000
2 MKOKUS – F 2	.87929	.76480	.09141	.69693	1.06165	9.619	69	.000
3 MAGTUP – F 3	2.18329	2.05088	.24513	1.69427	2.67230	8.907	69	.000
4 MPGVCN – F 4	-2.04286	1.92945	.23061	-2.50292	-1.58280	-8.858	69	.000
5 MPGHCR – F 5	-1.48571	3.59445	.42962	-2.34278	-.62865	-3.458	69	.001
6 MPGPIK – F 6	-1.52857	4.35964	.52108	-2.56809	-.48905	-2.933	69	.005
7 MFLPRK - F 7	-4.75714	6.31638	.75495	-6.26323	-3.25105	-6.301	69	.000
8 MFLISK - F 8	-9.97143	11.40680	1.36337	-12.69128	-7.25157	-7.314	69	.000
9 MFLPRS - F 9	18.87143	10.13949	1.21190	16.45375	21.28911	15.572	69	.000
10 MFESDM – F 10	-17.58571	16.22620	1.93940	-21.45472	-13.71671	-9.068	69	.000
11 MFEBML - F 11	-8.44286	6.22439	.74396	-9.92701	-6.95870	-11.349	69	.000
12 MFESUN – F 12	-3.48571	7.69292	.91948	-5.32003	-1.65140	-3.791	69	.000
13 MRCPTL – F 13	-2.91429	3.87389	.46302	-3.83798	-1.99059	-6.294	69	.000
14 MRCZTL – F 14	-8.55714	10.11046	1.20843	-10.96790	-6.14639	-7.081	69	.000
15 MRCSKL – F 15	-7.41429	6.05648	.72389	-8.85840	-5.97017	-10.242	69	.000
16 MBFTAR – F 16	-3.97143	1.75261	.20948	-4.38932	-3.55353	-18.959	69	.000
17 MBFTAN – F 17	-1.91429	1.12601	.13458	-2.18277	-1.64580	-14.224	69	.000
18 MBFPZD – F 18	-.55714	3.17890	.37995	-3.31512	2.20084	-3.466	69	.007

When the results of the T-test motor variables (Table 6) showed no statistically significant difference between the initial and final measurements, the final measurement of the experimental group was given favour. Statistically significant differences were achieved in all the studied variables of the experimental group.

Analysis of the results obtained for partial quantitative changes (T-test) in the variables used to estimate the handball and football motion structures performed in the experimental group

Based on the results of arithmetic means in variables used to estimate the handball and football motion structures in the initial and final measurements of the experimental group (Table 7), and on the basis of the change (difference) significance tested using the T-test for paired samples (Table 8), it is clear that the applied teaching and additional work programme (2 + 2 hours) for the aforementioned group of respondents as a whole, produced significant partial quantitative results.

Table 7: Descriptive statistics, T-test

Pair	Mean	N	Std. Deviation	Std. Er. Mean
1 SNVLSL- F	20.1091-17.4100	70	4.57846-2.93056	.54723-.35027
2 SNHOLZ-F	13.5571-17.0286	70	2.65197-1.26229	.31697-.15087
3 SNSONL-F	15.2000-18.8294	70	4.49670-4.13778	.53746-.49456
4 SNBVPP-F	15.5249-10.9119	70	1.44024-1.07269	.17214-.12821
5 SRBLHZ-F	11.1857-12.9286	70	2.63913-2.26710	.31544-.27097
6 SRULKO-F	6.7429-8.2286	70	1.25900-.98056	.15048-.11720
7 SRLVSL-F	12.0904-10.9289	70	.79012-.56211	.09444-.06719
8 SRILUD-F	36.5000-39.9143	70	4.33305-4.79052	.51790-.57258

After examining Table 8, we can conclude that no statistically significant difference between the initial and final experimental group measurement was achieved in the final measurement of all the variables used to estimate the handball and football motion structures.

Table 8: The movement structures change (difference) significance in the initial and final experimental group subjects' testing using the T-test

Pair	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
1 SNVLSL – F	2.69914	2.79696	.33430	2.03223	3.36605	8.074	69	.000
2 SNHOLZ – F	-3.47143	2.32018	.27731	-4.02466	-2.91820	-12.518	69	.000
3 SNSONL – F	-3.62943	3.39332	.40558	-4.43854	-2.82032	-8.949	69	.000
4 SNBVPP – F	4.61300	1.73155	.20696	4.20013	5.02587	22.289	69	.000
5 SRBLHZ – F	-1.74286	2.63579	.31504	-2.37134	-1.11437	-5.532	69	.000
6 SRULKO –F	-1.48571	1.69178	.20221	-1.88910	-1.08232	-7.348	69	.000
7 SRLVSL – F	1.16157	.68239	.08156	.99886	1.32428	14.242	69	.000
8 SRILUD - F	-3.41429	5.69132	.68024	-4.77133	-2.05724	-5.019	69	.000

This means that the applied regular and extra work plan in teaching physical and health education, to master the elements of handball and football movement structures entirely justified its goal, i.e. to contribute to improving the adoption of motor skills in selected sports games.

CONCLUSION

The study was conducted on a sample of 140 male high school students, divided into two sub-samples (control and experimental group) consisting of 70 students each. The control group was included in the regular physical education curriculum lasting two hours per week, while the experimental group, in addition to the regular two hours, had two more hours of physical education with the use of handball and football motion structures for the period of one school term. To monitor changes in the studied area, a test battery consisting of 18 motor variables and 8 variables (4 handball, and 4 football) for monitoring and evaluating the handball and football movement structures were applied. In order to determine the partial quantitative changes (partial success quantitative changes), especially those occurring in tests to assess motor skills, a T-test for paired samples was applied. The results of the T-test for paired samples at the beginning and at the end of the scheduled measurements show us that there were significant partial quantitative changes in the variables of the study motor space. In order to determine the partial quantitative changes (partial success quantitative changes), especially for changes in the tests for assessing and monitoring the movement structures of handball and football, the T-test for paired samples was also applied. The results of the T-test for paired samples at the beginning and at the end of the scheduled measurements show us that there were significant partial quantitative changes in variables for assessing and monitoring the area of handball and football motion structures. These results indicate that the program implemented in schools has a true impact on changes when it comes to motor skills and movement structures, which provides support for new research to improve the teaching and preparing relevant scientific data.

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ANALIZA PARCIJALNIH KVANTATIVNIH PROMJENA PRIMIJENJENIH BAZIČNIH MOTORIČKIH VARIJABLI I VARIJABLI ZA PROCJENU KRETNIH STRUKTURA IZ NOGOMETA I RUKOMETA

U cilju utvrđivanja parcijalne kvantitativne razlike (parcijalni kvantitativni rezultati promjena) i to za promjene u testovima za procjenu 18 istraživanih motoričkih sposobnosti i 8 testova za procjenu kretnih struktura iz rukometa i nogometa, kod obje istraživane grupe ispitanika (kontrolne i eksperimentalne), primijenjen je univarijantna razina testiranja - T-test za zavisne uzorke. Istraživanje je provedeno na uzorku od 140 učenika srednjih škola, muškog spola, podijeljenih na dva subuzorka (kontrolnu i eksperimentalnu grupu) od po 70 učenika. Kontrolna grupa je bila obuhvaćena redovitim planom i programom nastave tjelesnoga i zdravstvenoga odgoja od dva sata tjedno, dok je eksperimentalna grupa pored redovita dva sata imala i dva dodatna sata nastave tjelesnoga odgoja uz primjenu kretnih struktura iz rukometa i nogometa u trajanju od jednog školskog polugodišta. Rezultati su pokazali da u cilju utvrđivanja parcijalnih kvantitativnih promjena (parcijalni kvantitativni uspjesi promjene) rezultati T-testa za zavisne uzorke na početku i na kraju provedenog programa mjerenja ukazuju nam da je došlo do značajnijih parcijalnih kvantitativnih promjena u varijablama istraživanog motoričkog prostora. U cilju utvrđivanja parcijalnih kvantitativnih promjena (parcijalni kvantitativni uspjesi promjene) i to posebno za promjene u testovima za procjenu i praćenje kretnih struktura iz rukometa i nogometa, rezultati T-testa za zavisne uzorke na početku i na kraju provedenog programa mjerenja ukazuju nam da je došlo do značajnijih parcijalnih kvantitativnih promjena u varijablama za procjenu i praćenje prostora kretnih struktura iz rukometa i nogometa.

Ključne riječi: motoričke sposobnosti, kretne strukture, T-test, učenici, nogomet, rukomet.

Received: January 5, 2017 / Accepted: February 1, 2017
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A COMPARATIVE STUDY OF VELOCITY REDUCTION ON FEATHER AND SYNTHETIC SHUTTLECOCKS USING CORRECTED INITIAL VELOCITY DURING AN OVERHEAD SMASH

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ABSTRACT

Background: In this study, the flight performance of three shuttlecock models from different companies, one made with feather material and the others with nylon (plastic), were investigated during an overhead smash. Overhead smash is a complex condition where high velocity takes place. The shuttlecock is aerodynamically shaped and has low mass, thus it decelerates very quickly as it flies in the air due to the drag force of the air. Since understanding in the area of a high-speed situation during overhead smash is limited, the main objective of this study is to conduct a comparative analysis of natural feather and synthetic shuttlecock velocity reduction using a regression equation to obtain initial velocity. Method: This study involved right-handed, 20-years-old university badminton players, with a 1.72m in height, weighing 60kgs. After a general and a specific badminton warm-up, the subjects were asked to hit eight shuttlecocks with a maximal speed smash shot. The shuttlecock trajectory was recorded using a high-speed video camera (Phantom Miro-eX2, USA) set at 200 frames/sec and 1/2000 exposure time. The camera was positioned at the right-centre side of the badminton court, so that the optical axis of the camera lens was almost perpendicular to centre of the net position, with an approximate horizontal distance of 22m. The cork of shuttlecock was digitized using Frame DIAZ IV software analysis. Results: The present investigation has developed a regression approach based calculation for obtaining initial velocity during an overhead smash. This approach enables the determination of racquet-shuttlecock impact position and initial velocity for the overhead smash whilst overcoming the difficulties present. Thus, the material of the head had a high possibility of affecting its initial velocity. Since the test was conducted using the same racquet for every trial, thus the effect of the restitution of the racquet strings can be eliminated. Conclusion: The calculation of initial velocity (after impact) using the regression approach was successfully conducted. The comparison shows that the nylon Mizuno shuttlecock had the highest velocity reduction after certain distances (5 and 9 m). Feather and nylon Gosen have similar initial velocity. However, the nylon Gosen was less affected by air restriction (drag force) in comparison to the feather one.

Keywords: Initial velocity, Shuttlecock, Overhead smash, Badminton.

INTRODUCTION

Badminton is one of the most popular and oldest sports on earth. It is reported that over 200 million people played badminton around the world [1]. The badminton game is a racquet sport played with a feather shuttlecock. The shuttlecock is aerodynamically shaped and has low mass, thus it decelerates very quickly as it flies in the air due to the drag force of the air [2]. The shuttlecock is made of the natural feather and synthetic rubber. Generally, both types of shuttlecocks have a mass of around 4.75 – 5.50 grams, the diameter of the cork is 25 – 28 mm and the diameter of the circle is around 54 mm. Most amateur players use a synthetic shuttlecock because it is more durable and cheaper compared to the feather one which is predominantly used by professional players. The flight trajectories of the feather and synthetic shuttlecocks are significantly different from those pertaining to the balls utilized in most racquet sports due to a very high initial speed [3], [4].

For years, researchers have been studying the nature of shuttlecock regarding its trajectory, material, rotation, etc. Several studies had been conducted to investigate the parabolic trajectory of the shuttlecock [1], [5]. A study of different Reynolds numbers (Re) shows a low drag coefficient for a shuttlecock without a gap in comparison to the one with a gap [6]. The comparison between natural feather and synthetic shuttlecocks shows lower drag force for natural feather ones when tested in a wind tunnel [1], [3]–[5], [7]–[9].

However, one should keep in mind that the calculation of the drag force, theoretically, is highly affected by the initial velocity (after impact). Thus, the initial velocity should be observed carefully to obtain the correct value of the drag force.

Among the badminton skills, the overhead smash stroke is the most powerful shot and it is complex because of its speed and steep trajectory [10]. The speed of a shuttlecock decreases significantly due to the drag force that was highly influenced by the initial velocity [2]. Several methods have been used to measure traveling speed such as radar gun and the high-speed camera. However, both methods cannot measure initial velocity. The radar gun requires a highly capable operator so it can be used effectively. Also, it cannot differentiate the targets (racquet and shuttlecock), and thus the operator plays an important role [11]. And most importantly, the radar gun measures instantaneous speed rather than initial speed. On the other hand, the high speed camera is very expensive for higher specs. And speed calculation using the high-speed camera is most likely to produce an average or instantaneous speed, because of the difficulty of obtaining the figure exactly when the impact between the racquet and shuttlecock occurs [8]. The position of the shuttlecock, when it just releases from the net of a racquet is really hard to determine. In addition, low picture quality and insufficient sampling frequency are among the list of the problems[10]. Fortunately, in a real situation (not in the wind tunnel), most of the studies investigated in the area of low shuttlecock velocity viewed it like a drop shot, so inaccuracy of initial speed can be negligible. Since understanding in the area of a high-speed situation during overhead smash is limited, the main objective of this work is a comparative analysis of natural feather and synthetic shuttlecock velocity reduction using a regression equation to obtain initial velocity. In addition, a comparison of the initial velocity of standing and jumping smashes on feather shuttlecocks was given.

METHODS

Procedure

The participant was a right-handed university badminton player, 20 years old, 1.72m height and had a mass of 60 kg. After a general and a specific badminton warm-up, the subject was asked to hit eight shuttlecocks with the maximal speed smash shot. The shuttlecock trajectory was recorded using a high-speed video camera (Phantom Miro-eX2, USA) set at 200 frames/sec and 1/2000 exposure time. The camera was positioned at the right-centre side of the badminton court so that the optical axis of the camera lens was almost perpendicular to centre of the net position with an approximate horizontal distance of 22m. Figure 1 shows the top view schematic of the badminton experiment set-up. The cork of the shuttlecock was digitized using Frame DIAZ IV software analysis.

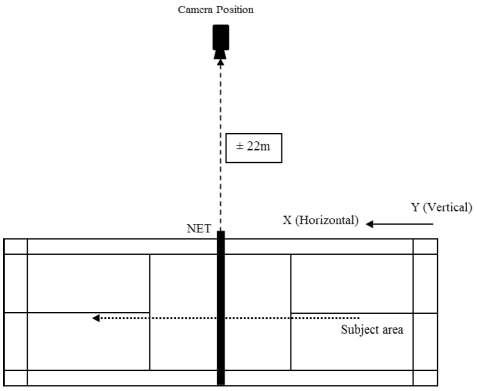

Figure 1: The top view schematic of the badminton experiment set-up

Shuttlecocks description

The shuttlecocks, selected for this study, were namely the natural feather (feather by the Yonex) and synthetics shuttlecocks (nylon-Mizuno and nylon-Gosen), see Figure 2. Generally, all types of shuttlecocks have a mass of around 4.7-5.5 grams. Table 1 shows the dimension of the feather and synthetic shuttlecocks in detail.

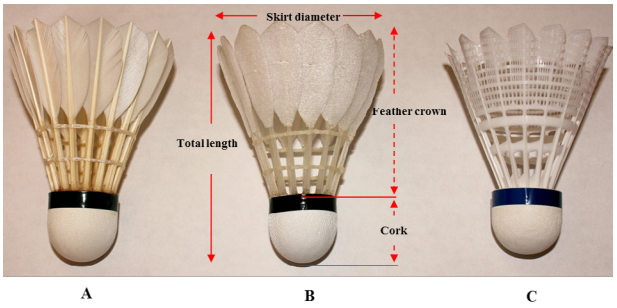

Figure 2: (A) The natural feather,
(B) nylon- Mizuno, and
(C) nylon-Gosen shuttlecock images

Table 1: Dimensions of the natural feather and synthetic shuttlecocks

Shuttlecock Characteristics	Shuttlecock Models		
	Feather (Yonex)	Synthetic (Gosen)	Synthetic (Mizuno)
Skirt diameter, d (mm)	66	66	66
Length of shuttlecock, H (mm)	89	82	87
Cork diameter, dn (mm)	26.5	26.5	26.5
Length of cork, l (mm)	5.0	5.0	5.0
Mass, m (gram)	26	22	24

Development of the calculation method

There were several stages to determine the shuttlecock initial speed by using a regression equation approach. First, identification of impact position between the racquet and shuttlecock. Second, drawing several velocities at several positions after the impact by simply using a frame based calculation, then generate the regression equation. Finally, inserting the information regarding its position into the regression equation. Figure 2 shows an athlete conducting an overhead swing in four frames (50 ms per frame). The impact between the racquet and shuttlecock occurred somewhere between frame 3 and 4. This also confirmed the difficulty in capturing the exact position of the impact. Figure 3 shows the racquet swing and a shuttlecock flight 5 frames after the shuttle release. The black box mark was the shuttlecock release point. The continuous-straight line and the discontinuous arrow line were the racquet swing and the shuttlecock flight analysis, respectively (the first to second phases or two frames after impact). The shuttlecock release point coordinate (X, Y) determined by a cross line interaction between the racquet swing ($Y = a1 \cdot X + b1$), and a shuttlecock path ($Y = a2 \cdot X + b2$) after impact were analysed by the regression equation approach (Figure 5).

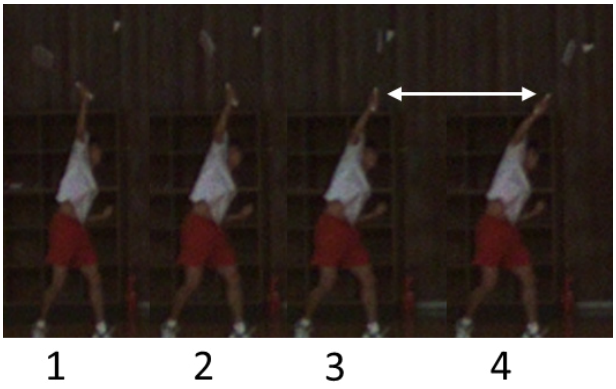

Figure 3: Racquet head swing and a shuttlecock before and after impact, the set-up camera speed is 200 fps with the 1/2000 shutter speed (1-4), the shuttlecock impact in the smash shot occurred between the numbers 3 and 4

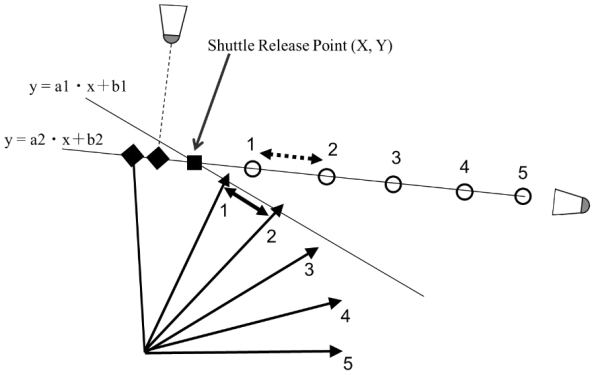

Figure 4: Racquet swing and the shuttlecock flight before and after impact captured using the stick picture image. From the first to the fifth phase, the racquet and the shuttlecock were at around 2m distance from the impact. The black box mark was the shuttlecock release point. The straight and discontinuous lines were the racquet swing and the shuttlecock flight analysis, respectively.

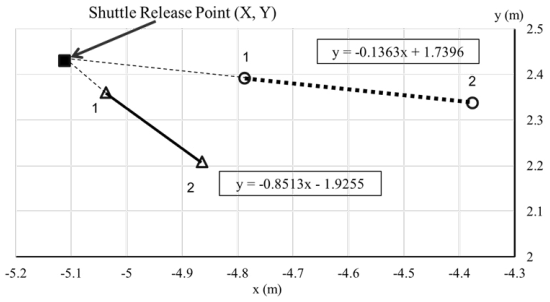

Figure 5: The straight and discontinuous lines showed the racquet swing and the shuttlecock flight after its release (the first and second phases, respectively)

From the description of the figure above, assisted by the statistical method least-squares method approach, the equation of a straight solid line for shuttlecock and dashed line racquet will be obtained as follows:

$$y_1 = (a_1)x_1 + (b_1)$$

Equation 1

$$y_2 = (a_2)x_2 + (b_2)$$

Equation 2

Number 1 is a representation of theposition of the shuttlecock and number 2 is the position of the racquet. The position of the object - 1 (shuttlecock) can be expressed mathematically as follows:

$$x_1(t) = -\frac{1}{2}a_{1x}\,t^2 + v_{1x}\,t + x_1(0)$$

Equation 3

$$y_1(t) = -\frac{1}{2}a_{1y}\,t^2 + v_{1y}\,t + y_1(0)$$

Equation 4

The position of the object - 2 (racquet) can be expressed mathematically as follows:

$$x_2(t) = -\frac{1}{2}a_{2x}\,t^2 + v_{2x}\,t + x_2(0)$$

Equation 5

$$y_2(t) = -\frac{1}{2}a_{2y}\,t^2 + v_{2y}\,t + y_2(0)$$

Equation 6

The impact of the racquet and shuttlecock is assumed to be at t = 0 s; assuming the acceleration of each object is zero, then the above equation will change to:

$$x_1(t) = v_{1x}\,t + x_1(0)$$

Equation 7

$$y_1(t) = v_{1y}\,t + y_1(0)$$

Equation 8

$$x_2(t) = v_{2x}\,t + x_2(0)$$

Equation 9

$$y_2(t) = v_{2y}\,t + y_2(0)$$

Equation 10

By substituting t between equations 7 and 8, as well as for the equations 9 and 10, the equations transform into:

$$y_1(t) = \left(\frac{v_{1y}}{v_{1x}}\right)x_1(t) + \left(\,y_1(0) - x_1(0)\left(\frac{v_{1y}}{v_{1x}}\right)\right)$$

Equation 11

$$y_2(t) = \left(\frac{v_{2y}}{v_{2x}}\right)x_2(t) + \left(\,y_2(0) - x_2(0)\left(\frac{v_{2y}}{v_{2x}}\right)\right)$$

Equation 12

By using position data of the racquet and shuttlecock at a certain time, t, then the value will be m1, b1, m2, and b2, where m is gradient while b is a cross line at the y-axis. The equation of a straight line will be obtained, as in figure 4. By finding the point of intersection of the two lines, we can obtain the point of intersection of the two lines, which is the point of impact between the racquet and shuttlecock. Points $P(x_1(0), y_1(0))$ are the same point with $P(x_2(0), y_2(0))$. This situation causes both objects, racquet and shuttlecock, to be at the same point. T = 0 s is the point P.

Because

$$x_1(0) = x_2(0) = x(0)\ ;\ y_1(0) = y_2(0) = y(0)$$

Equation 13

So

$$a_1 = \left(\frac{v_{1y}}{v_{1x}}\right) \; ; \; a_2 = \left(\frac{v_{2y}}{v_{2x}}\right)$$

$$b_1 = \left(y(0) - x(0)\left(\frac{v_{1y}}{v_{1x}}\right)\right) \; ; \; b_2 = \left(y(0) - x(0)\left(\frac{v_{2y}}{v_{2x}}\right)\right)$$

Equation 14

We will get 4 equations with 4 unknown parameters, namely: We will get 4 equations with 4 unknown parameters, namely:

$$V_{1x}, V_{1y}, V_{2x}, dan\ V_{2y}$$

Equation 15

At that time, the four parameters will be obtained. Then, the velocity of the racquet and shuttlecock at t = 0 s at the point P can be known. The next analysis was a regression equation using second-order polynomial functions from the first to the fifth phase or 5 frames after impact between X horizontal axis (m) and shuttle velocity (m/s) after shuttlecock release as shown in figure 6.

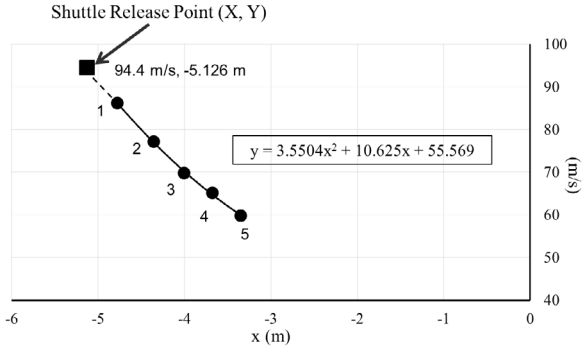

Figure 6: The regression equation using second order polynomial functions to determine the initial shuttle speed (0 m was the net line)

Finally, the initial velocity of the shuttlecock is determined by an X-axis value of the release point coordinate and the coefficient of the second order of the regression equation between shuttlecock velocity (m/s) and X axis (m). All the calculations were applied to three models of shuttlecocks. The results were then compared. Evaluation was conducted after 5 and 9 m traveling distance. Racquet initial velocity has also been evaluated.

RESULTS

Standing smash after 9 m traveling distance

Standing smash after 9 m traveling distance Tables 2-4 show initial and final velocities of the feather, Nylon Mizuno, and Nylon Gosen, respectively, for 5 m distance. All the data were obtained from 8 trials using different types of shuttlecocks. Table 2 shows that average initial velocity, i.e. using regression equation method, of the feather shuttlecock was about 86.1 m/s. On the other hand, the average final velocity was 29.8 m/s, it is about 34.7 % of initial velocity. Table 3 shows a value of 79.9 m/s for average initial velocity and 25.5 m/s for final velocity. This means that the final velocity was 31.8% of the initial velocity. The initial velocity of nylon Gosen was about 85.9 m/s, see Table 4.

Figure 7 shows the comparison of the initial velocities of the feather, nylon Mizuno, and nylon Gosen shuttlecocks. It can be seen that nylon Mizuno has the lowest initial velocity, while feather and nylon Gosen have a similar value. Figure 8 shows the final velocity of all the shuttlecocks. The nylon Mizuno has the lowest value, while the nylon Gosen has the highest value. These results show that the drag force affected the nylon Mizuno the most. And the nylon Gosen was less affected by the drag force of the air.

Table 2: The means of initial speed (m/s), final speed (m/s) and speed reduction (%) of the feather shuttlecock (5 m distance)

No	Distance (m)	Initial Velocity (m/s)	Final Velocity (m/s)	%
1	5	93.6	30.1	32.2
2	5	92.9	33.3	35.8
3	5	83	26.5	31.9
4	5	88.9	33.2	37.3
5	5	78	27.8	35.6
6	5	87.2	31.2	35.8
7	5	75.2	27.6	36.7
8	5	89.6	28.9	32.3
Average	5	86.1	29.8	34.7

Table 3: The means of initial speed (m/s), final speed (m/s) and speed reduction (%) of the Nylon Mizuno (5 m distance)

No	Distance (m)	Initial Velocity (m/s)	Final Velocity (m/s)	%
2	5	62.4	22.2	35.6
3	5	95.8	28.8	30.1
4	5	79.6	22.1	27.8
5	5	76.2	26.1	34.3
6	5	72.4	27.1	37.4
7	5	81.8	27.2	33.3
8	5	91.3	24.7	27.1
Average	5	79.9	25.5	31.8

Table 4: The means of initial speed (m/s), final speed (m/s) and speed reduction (%) of the Nylon Gosen (5 m distance)

No	Distance (m)	Initial Velocity (m/s)	Final Velocity (m/s)	%
1	5	84.9	34.9	41.1
2	5	91.9	36.6	39.8
3	5	75.3	34.2	45.4
4	5	88.5	36	40.7
5	5	82.7	33.2	40.1
6	5	87.1	36.8	42.3
7	5	92.4	34.1	36.9
8	5	84.6	35.7	42.2
Average	5	85.9	35.2	41

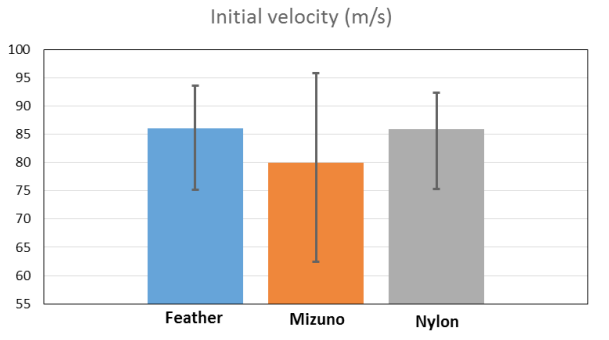

Figure 7: Initial velocity comparison of the feather, Mizuno and Nylon-Gosen

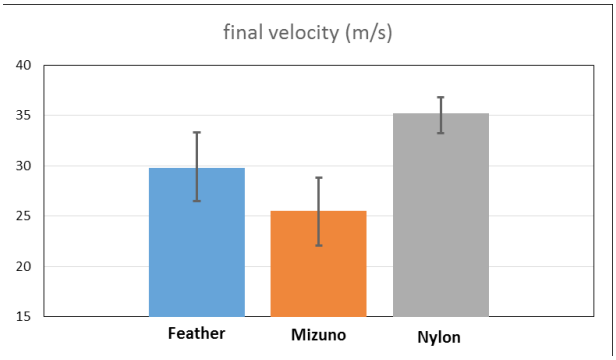

Figure 8: Final velocity comparison of the feather, Mizuno and Nylon-Gosen

Standing smash after 9 m traveling distance

Tables 5-7 show initial and final velocities of the feather, Nylon Mizuno, and Nylon Gozen, respectively, for 9 m distance. All the data were obtained from 8 trials using different types of shuttlecocks. Table 5 shows that average initial velocity, i.e. using regression equation method, of the feather shuttlecock was about 86.1 m/s. On the other hand, the average final velocity was 29.8 m/s, it is about 34.7 % of the initial velocity. Table 6 shows the value of 79.9 m/s for average initial velocity, with the value of 25.5 m/s for final velocity. And this means that the final velocity was 31.8% of initial velocity. The initial velocity of nylon Gosen was about 85.9 m/s, see Table 7. Figure 9 shows the final velocity of all the shuttlecocks after 9 m traveling. Overall, it has a trend similar to the result for 5 m (figure 8). However, after 9 m traveling, the value loses about 40% of velocity after 5 m.

Table 5: The means of initial speed (m/s), final speed (m/s) and speed reduction (%) of the feather shuttlecock (9 m distance)

No	Distance (m)	Initial Velocity (m/s)	Final Velocity (m/s)	%
1	9	93.6	11.8	12.6
2	9	92.9	12.4	13.3
3	9	83	10.7	12.9
4	9	88.9	13.6	15.3
5	9	78	11.8	15.1
6	9	87.2	11.8	15.1
7	9	75.2	11.1	12.7
8	9	89.6	11.4	15.2
Average	9	86.1	11.8	14

Table 6: The means of initial speed (m/s), final speed (m/s) and speed reduction (%) of the Nylon Mizuno (9 m distance)

No	Distance (m)	Initial Velocity (m/s)	Final Velocity (m/s)	%
2	9	62.4	8.2	13.1
3	9	95.8	10	10.4
4	9	79.6	8.8	11.1
5	9	76.2	10.2	13.4
6	9	72.4	11.1	15.3
7	9	81.8	9.3	11.4
8	9	91.3	10.2	11.2
Average	9	79.9	9.7	12.1

Table 7: The means of initial speed (m/s), final speed (m/s) and speed reduction (%) of the Nylon Gosen (9 m distance)

No	Distance (m)	Initial Velocity (m/s)	Final Velocity (m/s)	%
1	9	84.9	15.2	17.9
2	9	91.9	15.4	16.8
3	9	75.3	14.1	18.7
4	9	88.5	15.4	17.4
5	9	82.7	13.3	16.1
6	9	87.1	14.5	16.6
7	9	92.4	14.4	15.6
8	9	84.6	14.3	16.9
Average	9	85.9	14.6	17

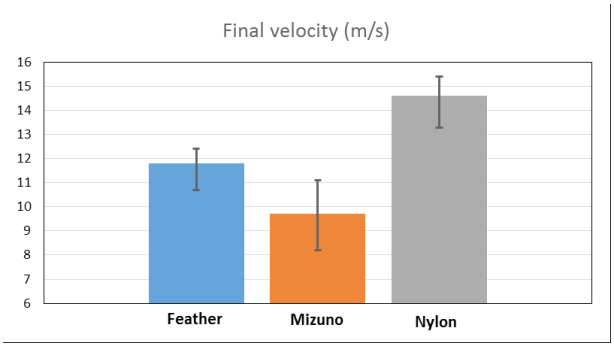

Figure 9: Final velocity comparison of the feather, nylon Mizuno, and Nylon-Gosen

Standing vs. jumping smash Velocity (Feather)

Figure 10 shows a comparison of velocity profile between standing and jumping smashes using a feather shuttlecock. It can be seen that the initial velocity of a jumping smash is slightly higher than the standing smash. After traveling for 5 m and 9 m, the standing smash shows slightly higher velocity than the jumping smash. From the graph, it can be seen that velocity reduction was not linear. This is predictable, since the formulation of drag force utilizes quadratic velocity.

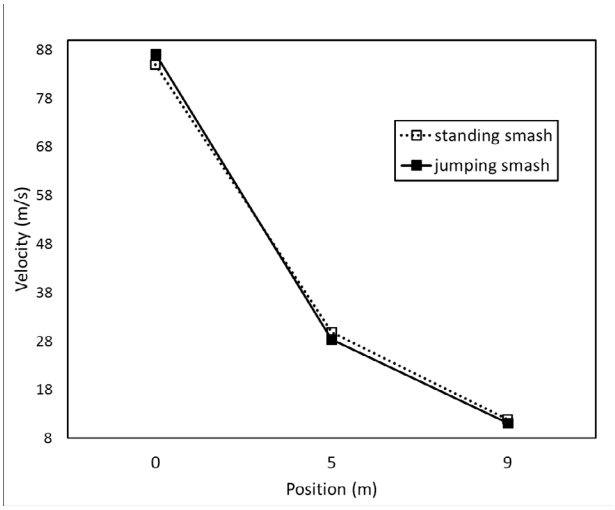

Figure 10: Comparison of velocity profile between standing and jumping smashes

Racquet velocity comparison

Table 12 shows a comparison of racquet velocity after impact with shuttlecocks performed through the standing smash. Roughly, the comparison shows slight differences among all velocities. However, the velocity after impact with feather shuttlecocks has the lowest average velocity, while nylon Mizuno has the highest velocity. The jumping smash on feather shuttlecocks shows an increase of racquet velocity in comparison with the standing smash.

Table 12: Comparison of racquet velocity right after the impact with particular shuttlecocks.

Shuttle	Feather	Nylon Mizuno	Nylon Gosen	Jumping Smash
Average (m/s)	54.7	56.1	55.4	55.9

DISCUSSION

The present investigation has developed a regression approach based calculation for obtaining initial velocity during an overhead smash. This approach enabled the determination of racquet-shuttlecock impact position and initial velocity for overhead smash whilst overcoming the difficulties present by other technology. Most previous studies investigate the trajectory of the shuttlecock during a drop shot where velocity is not so high [12], [13]. McErlain-Naylor et al. developed a method using the curve fitting method which is close to ours [14]. However, in this method, it was assumed that several positions at the beginning, just after impact, were still flying in a straight path [15].

The result of initial velocity (Figure 7) revealed that, after impact, the feather shuttlecock had a high initial velocity together with the nylon Gosen (small difference). This result may strongly be related to the material of the shuttlecock's head. Theoretically, the parameters that may affect initial velocity are mass, shooting power and restitution constant of the material. Since all of the tested shuttlecocks had the same mass, then this reason should be omitted. Thus, the material of the head had a high possibility of affecting its initial velocity. To elaborate more regarding this reason, further investigation should be conducted. A typical viscoelastic impact characterisation may appropriate for testing [16]. Since the test was conducted using the same racquet for every trial, thus the effect of the restitution of the racquet strings can be eliminated.

The final velocity of the shuttlecock after 5 and 9 m seems to be following a negative exponential pattern. It was theoretically accepted since reduction of velocity is most likely due to drag force, which is affected by quadrat velocity. On the other hand, the difference of percentages among shuttlecocks may be due to stiffness of the material. After the impact, the shuttlecock will be in opposite direction with the vector velocity, after which it will rotate and have the same direction with the velocity. During this process, due to air resistance, the shuttlecock will be deformed a little bit, i.e. get wider, and as a consequence, the drag force will increase sharply. A material with high deformation (bigger dimension) will experience a higher drag force. According to the result, it seems that the nylon Mizuno has the highest deformation. And the least deformation is exhibited by the nylon Gosen or, in other words, this material had a high stiffness level. However, further investigation is needed to confirm this hypothesis; investigation on velocity before the shuttlecock rotates and points to the same direction as the velocity vector.

A comparison between the standing and jumping smashes using the feather shuttlecock as shown in Figure 10 shows a quite similar pattern and value, in other words, only a small difference occurs for both mechanisms. However, in detail observation, the jumping smash exhibits higher initial velocity than the standing position.

After the impact, the racquet velocity comparison shows a small discrepancy among all values. This shows that the racquet velocity was less affected by the type of shuttlecock. This might be due to the reality that the racquet connected to the human body had much higher moment inertia.

The method being used to calculate initial velocity was very useful to overcome the difficulty of such a complex (skill demanding) method and high cost method. More importantly, the method provides better observation of initial velocity, which will affect the calculation of drag (air) force. This method can be implemented using a low capturing speed camera. Thus, this will contribute to an improvement of the training methods in badminton around the world.

CONCLUSION

A calculation of initial velocity (after impact) using the regression approach was successfully conducted. A comparison on velocity reduction of the natural feather and synthetic shuttlecocks was conducted using the initial velocity data by a regression approach. The comparison shows that the nylon Mizuno shuttlecock had the highest velocity reduction after certain distances (5 and 9 m). Feather and nylon Gosen have similar initial velocity. However, the nylon Gosen was less affected by air restriction (drag force) in comparison to the feather one.

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KOMPARATIVNO ISTRAŽIVANJE SMANJENJA BRZINE PERNATE I SINTETIČKE LOPTICE ZA BADMINTON KORISTEĆI KORIGOVANU INICIJALNU BRZINU PRILIKOM SMEČA

Relevantni podaci: U ovom istraživanju je ispitan let tri modela loptica za badminton, prilikom smeča, proizvedenih od strane različitih kompanija, gdje je jedna napravljena od perja, a druge od najlona (plastike). Smeč je kompleksno stanje koje se ogleda u postizanju velike brzine. Loptica za badminton je aerodinamična i ima malu masu, pa prema tome usporava veoma brzo zato što tokom leta na nju utiče sila otpora zraka. Uzimajući u obzir ograničeno razumijevanje situacije u kojoj se javlja velika brzina prilikom smeča, glavni cilj ovog istraživanja jeste provesti komparativnu analizu smanjenja brzine loptice za badminton napravljene od prirodnog perja i sintetike koristeći jednačinu regresije kako bi se dobila inicijalna brzina. Metoda:U ovom istraživanju su sudjelovali univerzitetski igrači badmintona, dešnjaci, starosti 20 godina, visine 1,72m i težine 60 kg. Nakon općeg i specifičnog zagrijavanja za badminton, od ispitanika se tražilo da izvrše 8 smečeva sa lopticom za badminton maksimalne brzine udarca. Putanja loptice za badminton je izmjerena koristeći video kameru za velike brzine (Phantom Miro-eX2, USA) podešenu za snimanje 200 kadrova u sekundi sa ekspozicijom 1/2000. Kamera je smještena na sredini desne strane terena za badminton kako bi optička osa leće kamere bila gotovo okomita u odnosu na sredinu mreže sa približnom horizontalnom udaljenosti od 22m. Baza loptice za badminton je digitalizirana koristeći Frame DIAZ IV analizu putem računalnog softwarea. Rezultati: Ovim istraživanjem je razvijena kalkulacija regresije za dobivanje inicijalne brzine prilikom smeča. Ovaj pristup omogućava utvrđivanje mjesta udarca reketa i loptice za badminton, te inicijalne brzine smeča, prevazilazeći trenutne poteškoće. Prema tome, velika je vjerovatnoća da je materijal baze uticao na inicijalnu brzinu. S obzirom da je testiranje izvršeno koristeći isti reket za svaki pokušaj, efekat koeficijenta restitucije mreže reketa se može eliminisati. Zaključak:Kalkulacija inicijalne brzine (nakon udarca) koristeći regresiju je uspješno provedena. Usporedba pokazuje da je Mizuno loptica za badminton napravljena od najlona imala najveće smanjenje brzine nakon prelaska određene udaljenosti (5 i 9 m). Gosen loptice za badminton napravljene od perja i nalona su imale sličnu brzinu. Međutim, na Gosen lopticu za badminton napravljenu od najlona je manje uticao otpor zraka (sila otpora zraka) u odnosu na lopticu od perja.

Ključne riječi: Inicijalna brzina, loptica za badminton, smeč, badminton.

Received: April 12, 2017 / Accepted: May 23, 2017
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DIFFERENCES IN SOME ANTHROPOLOGICAL CHARACTERISTICS OF CHILDREN ATHLETES AND NON-ATHLETES IN ELEMENTARY SCHOOL

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ABSTRACT

In this study, the differences in some anthropological characteristics of children athletes in elementary school and the children who are not involved in sports were researched. The study was conducted on a sample of 79 subjects who attend primary school. Testing was done on the sample of the sixth, seventh and eighth grades. 9 tests to assess the anthropometry, flexibility, speed, static strength, explosive strength, repetitive strength and functional abilities were applied to the sample of 79 respondents. Discriminant analysis showed statistically significant differences between children athletes and non-athletes from elementary school. These subjects are differentiated the most in the test for the assessment of aerobic endurance and static strength.

Keywords: anthropological characteristics, differences, young athletes-non-athletes.

INTRODUCTION

Motor skills are defined as an ability which allows the realization of all kinds of changes (Milanovic, 2009). Kondrič (2000) notes that motor skills are defined as a mutual set of dimensions responsible for the successful resolution of motor problems. Morphological measures describe the structure of the body, or somatotype features athletes. Training can influence the development of muscle mass and reducing body fat, while some of the morphological features, such as longitudinal and transversal measures of skeleton can modify any training Sun, L. (2015). Prahović and Protic (2007) conducted their work to investigate differences in the anthropological characteristics between the fourteen year old football players, basketball players, handball players and those who are not involved in sports. From the results it became clear that there are significant differences in most motor and functional abilities, especially among boys - non-athletes and those who are in the training process for two years.

Sertić, Budinšćak and Segedi (2008), in their study, compared the differences in some anthropological characteristics between thirteen-year-old boy wrestlers and boys and girls non-athletes who are engaged in some other sport. By comparing the results of the tests to assess the results pertaining to the 13-year-old boys' anthropological status, significant differences were revealed in 6 of the 11 variables between wrestlers and boys engaged in some other (non-wrestler) sports. Vrbik, Čižmek and Peršun (2011) conducted their work to determine the differences in motor skills of high school athletes and non-athletes. In my work, I analysed the differences based on the diagnosed condition of high school students, who attend school physical education once a week and do not participate in organized sports activities and high school students who are taught physical education once a week and participate in football training three times a week. The results showed that the students who attended mandatory PE classes and football training three times a week were significantly different from the students who

exclusively attended PE classes, as well as that the levels of their motor abilities: agility, explosive strength types of horizontal vertical jump, flexibility lumbar back and coordination were also different. Petrić, Cetinić and Dario Novak (2010); Katić et al. (1998), Delija, Šimenc, Vuleta, (1995); Čavlović, (2010) Žuvela (2003) and Kajtna, Tušak, Baric and Burnik (2004) obtained similar results.

OBJECTIVE

The objective of this research is to determine whether there are significant differences in some anthropological characteristics between children attending a basic programme of physical education who train another sport and children who just attend a basic programme of physical education.

WORK METHODS

The sample survey was conducted on a sample of 79 students who attend the 6th, 7th and 8th grade: First Elementary School in Široki Brijeg. The variables were applied for the following tests: Weight-TEZ; Height-VIS; Hand tapping in 15 seconds-MTR; Speed 60m-B60m; Long jump-SDM; Sit-ups-MPT; Bent arm hang-MIV; V sit and reach-MPR; 6 min. run-F6.
The methods of data processing Data was analysed in Statistica for Windows, ver.9.0. Descriptive statistics, a T-test for independent samples and discriminant analysis were calculated for signs of differences between student athletes and non-athletes.

RESULTS AND DISCUSSION

Table 1: Total descriptive statistical parameters

	N	AS	SD	MIN	MAX
VIS - Height	79	162.0	8.6	137	180
TEZ – Weight	79	50.7	9.3	31	79
MTR – Hand tapping	79	27.8	3.5	20	37
SDM – Long jump	79	168.3	23.7	102	220
MPT – Sit-ups	79	34.2	9.0	4	49
MPR – V sit and reach	79	59.9	13.5	28	90
MIV – Bent Arm Hang	79	22.7	20.5	1	100
F6 – Run 6 min	79	1087.4	124.3	760	1350
B60m – Speed 60m	79	10.7	1.0	8.5	13

Legend:
- number of subjects; AS - mean;
SD -standard deviation;
MIN -lowest score;
MAX – largest score.

Table 1 shows the basic descriptive indicators. In the T-test, there were statistically significant differences between athletes and non-athletes in the measured variables.

Table 2: Values of the T-test

VAR	Athletes	Non-athletes	t-value	df	p
VIS	162.552	161.694	0.4227	77	0.6736
TEZ	49.379	51.490	-0.9704	77	0.3349
MTR	29.759	26.592	4.2880	77	0.0000*
SDM	184.034	158.939	5.2334	77	0.0000*
MPT	38.379	31.653	3.4021	77	0.0010*
MPR	62.655	58.347	1.3686	77	0.1751
MIV	37.897	13.714	6.1203	77	0.0000*
F6	1186.897	1028.571	6.8800	77	0.0000*
60m	9.990	11.057	-5.2943	77	0.0000*

Legend:
VAR - variable,
t-value - the result of the T-test,
df - degrees of freedom,
p - level of significance

The students showed significant difference in the variables: MTR, SDM, MPT, MIV, and F6 60m. MIV variable is statistically, significantly deviated from the normal distribution, and therefore calculated using the Mann-Whitney U test.

Table 3: The Mann-Whitney test

	Rank Sum S	Rank Sum N	U	Z	p-level of significance
MIV	1611.500	1556.500	244.5000	4.81799	0.000001*

After the calculation of basic statistical parameters for variables and the T-test, we created a discriminant analysis that shows the significance of differences between group entities measured in several variables and how certain variables contribute to the difference. This analysis is possible to forecast the group affiliation of each entity.
The results of the discriminant analysis prove non-affiliation within the same population.

Table 4: Analysis of the difference between student groups of athletes and non-athletes

Eigen-value	Canonicl R	Wilks' Lambda	Chi-Sqr.	df	p-level
0.9857	0.7045	0.5035	49.0491	9	0.0000

Legend:
eigenvalue = inherent value;
R = canonical correlation;
Wilks lambda = lambda Wilks test;
chi-sqr. = Hi-square test;
df = degrees of freedom;
p-level = level of significance

The discriminant function is significantly different for students who attend the basic programme of physical education and train other sports and students who only attend a basic programme of physical education on the significance level (p 0.0000). After determining the significance, the next step is to interpret how much is the variable associated with the discriminant function. We need to determine the structure of the discriminant function to see which variable contributes more, and which one less to differences in the groups.

Table 5: Structure of the discriminant function

	Root 1
VIS	0.0488
TEZ	-0.1121
MTR	0.4954
SDM	0.6046
MPT	0.5335
MPR	0.1581
MIV	0.7071
F6	0.8221
60m	-0.6116

The structure and centroids discriminant function variables showed the dominance of aerobic functional abilities (F6) in the discrimination of these two sub-groups, where there is dominance in the explosive power and speed of students with a basic programme of physical education who practice some other sport. According to Table 6, we see that the students with the basic programme of physical education who train some other sports and students who only attend a basic programme of physical education exhibit differences in the variables F6 – running for 6 minutes and MIV – bent arm hang.

Table 6: Position of the group centroid on discriminant function

	Root 1
Athletes	1.2739
Non-athletes	-0.7539

According to the centroid position of the group, we can say that the groups of students differ significantly.

CONCLUSION

The study was conducted on 79 students from the First Primary School in Široki Brijeg, out of which 28 attend the sixth, 27 the seventh and 27 the eighth grade. Out of all the subjects, 30 students attend the basic programme of physical education and practice some other sport and 49 students only attend the basic programme of physical education. The aim of the research was to determine the extent to which some motor skills and morphological characteristics differ between children with a basic programme of physical education who also train other sports and children who just attend a basic programme of physical education. Students differ the most in the test for aerobic endurance F6 – running for 6 minutes and in the test MIV – bent arm hang. Students who, apart from the basic programme of physical education, also practice some other sport achieved a steady improvement in motor skills, as seen in this study.

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RAZLIKE U NEKIM ANTROPOLOŠKIM VARIJABLAMA DJECE SPORTAŠA I NESPORTAŠA OSNOVNOŠKOLSKE DOBI

U ovom radu istraživane su razlike u nekim antropološkim obilježjima djece sportaša u osnovnoj školi i one djece koja se ne bave sportom. Istraživanje je provedeno na uzorku od 79 ispitanika koji pohađaju osnovnu školu. Testiranje je provedeno na učenicima šestog, sedmog i osmog razreda. Na uzorku od 79 ispitanika primijenjeno je 9 testova za procjenu antropometrije, fleksibilnosti, brzine, statičke snage, eksplozivne snage, repetitivne snage i funkcionalnih sposobnosti. Diskriminacijska analiza je pokazala statistički značajne razlike između djece sportaša i nesportaša iz osnovne škole. Navedeni ispitanici se najviše razlikuju u testu za procjenu aerobne izdržljivosti i statičke snage.

Ključne riječi: antropološka obilježja, razlike, djeca sportaši-nesportaši.

Received: February 17, 2017 / Accepted: March 20, 2017
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DIFFERENCIES BETWEEN BASKETBALL PLAYERS AND 15-YEAR-OLD STUDENTS IN SOME ANTHROPOMETRIC FEATURES AND MOTOR SKILLS

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ABSTRACT

The research was conducted on a sample of 100 young pupils aged 14-15, in two schools; the first one was an elementary school and the second was a basketball club from Priština. The purpose of the study was to prove the possible difference between the basketball players and the pupils in some anthropometric characteristics, basic motor skills and situational motor skills. In order to define these changes of anthropometric characteristics, 18 variables were applied for basic motor and situational motor skills. The survey data were processed with descriptive statistical methods and through a T-test. The results show that there are statistically significant differences and that there is a statistically significant difference between basketball players and pupils, where basketball players have better results in all tests of basic motor and situational motor skills. The results have shown that the regular engagement of children in basketball schools can enhance the skills and knowledge of young players and make a significant difference.

Keywords: anthropometric characteristics, basic motor skills, basketball players, students, T-test.

INTRODUCTION

Basketball is a sport that is followed by millions of spectators around the world. In our country, it also has a vast interest and viewership. The Basketball Game is consisted of many complex anthropological features where agility, explosive strength and speed, are essential in performing many motor structures. Creating a large number of basketball schools in our country, in recent years, represents additional requirements to recognize the basic principles for the development of programs that are as qualitative as possible for the players. After the acceptance of Kosovo Basketball Federation in FIBA, there is a great interest for technical-professional capacity building of our coaches and officials that are directly or indirectly involved with the basketball game. Taking into consideration the values of anthropometric and motor parameters of Kosovo youth, we selected appropriate methods, in order to transform and orientate the youth in sports tracks. Similar research in the field of basketball were done by the author Dezhman (1996), who handled the morphological system and motor status for young basketball players, which is an important information for the effectiveness of the basketball game. Šabotić & Drobnjak (2007) have verified the connectivity of predictive variables and basic-motor skills with criteria variables for the youth of 15 years of age. Salihu (2003), in his doctoral dissertation, has done similar research in the field of basic and situational motor skills with basketball players. In this project we will deal with youth – 15-year-old teens. Through this work we will try to verify the morphology and differences of basic and situational motor skills or specific skills of the basketball players, who are active members in the clubs from Priština and students of SHFMU "Faik Konica" Priština.

METHODS

In this research the samples are taken from 100 young people, aged 14-15, males, from the municipality of Priština. The first group consisted of 50 students from Basketball Schools "M-Junior" and "Prishtina Pro-Basket". The second group consisted of 50 students from the Elementary School "Faik Konica". All the anthropometric measurements were made in the morning hours, while those of basic and situational motors skills were taken in the afternoon hours.

The sample of variables

In this paper, eight variables of anthropometric characteristics, five basic motor skills variables and four situational motor skills variables were treated, as follows:

Anthropometric variables

APESHA – Body weight, ALARTË – Body height, AGJKRA – Length of the arm, AGJEKR – Width of the arm, AGJKËM – Length of the leg, APEKOF – Circumference of the thigh, APEKËR – Circumference of the calf, APEKRA – Circumference of the arm.

Basic motor skills variables

MKGJVE – Sanding Long jump, MHTMSH – Medicine ball throw (3 kg) from the laying position, MHTMUK – 3 kg medicine ball throw while sitting in the chair, MV20ML – High-start 20 m running, MV2x10L – High-start 2x10 meters running.

Situational motor skills variables

MSD20P – Dribbling with obstacles, round-trip 20m, 4 obstacles, distance 1.5m, MSGJLI – Free throws – distance 3.37m, 5 throws, MSGJLM – Free throws from the left side – distance 2.77m, 5 throws, MSGJLD – Free throws from the right side – distance 2.77m, 5 throws.

Statistical analysis

The results were analysed using the statistical program SPSS, version 20.00. Descriptive analysis, basic statistical parameters for each variable, as well as measures of asymmetry were applied for both groups' system of variables.

- The minimum and maximum values (R. min-R. max).
- Arithmetical average (Ma).
- Standard deviation (Ds)
- Asymmetry parameters (SKEW and KURT).
- In order to determine the difference between the two groups, in this case between basketball players and students, in both areas we will use analysis of a T-test for independent samples.

RESULTS AND DISCUSSIONS

In Table 1, the students' anthropometric values are presented and through a descriptive analysis are given basic statistical parameters. Based on these results, it is worth mentioning that all the variables showed normal distribution, except the variable body weight, where the distribution is normal, but with a higher rate and it shows a more emphasised deviation from minimum and maximum results In other variables, the distribution is within normal limits and the group is presented as fairly homogenous in completing the assignments for fulfilling relevant tests. Also, Table 2 shows the results of basic statistical parameters in the students' basic and situational motor skills area, where it is noticed that the group is homogeneous except for the situational motor skill variable of 20m dribbling.

Table 1: Basic statistical parameters of anthropometric variables among students

Variables	No	Min	Max	Mean	Std. Dev.	Skew	Kurt
APESHA	50	39.70	98.50	64.57	11.254	.598	.713
ALARTË	50	159.00	189.00	174.22	.061	.146	.095
AGJKRA	50	72.00	90.00	78.70	.046	.465	-.449
AGJEKR	50	162.00	197.00	176.06	.077	.593	.318
AGJKËM	50	94.00	112.00	102.52	.044	.263	-.432
APEKOF	50	40.00	60.00	50.24	.044	-.062	-.302
APEKËR	50	30.00	45.00	36.60	.031	.146	.206
APEKRA	50	21.00	32.00	26.22	.026	.307	-.518

Table 2: Basic statistical parameters of basic-situational motor skills variables among students

Variables	No	Min.	Max.	Mean	Std. Dev.	Skew	Kurt
MKGJVE	50	140.00	255.00	190.42	.237	.263	.157
MHTMSH	50	340.00	605.00	472.62	.783	.018	-1.258
MHTMUK	50	310.00	640.00	446.80	.722	.553	.287
MV20ML	50	2.53	3.95	3.15	.344	.502	-.268
MV2x10L	50	7.84	12.21	9.56	.913	.767	.671
MSD20P	50	7.56	20.70	12.46	3.183	.842	.115
MSGJLI	50	1.00	5.00	2.72	1.069	.386	-.478
MSGJLM	50	1.00	5.00	2.74	.964	-.155	-.333
MSGJLD	50	.00	5.00	2.36	1.156	.232	-.150

In tables 3 and 4, anthropometric values of the basketball players' basic and situational motor skills are presented. Through a descriptive analysis, basic statistical parameters are given, and based on these results it is worth mentioning that all the variables showed normal distribution, except body weight and arm circumference variable that show a more emphasized deviation from the minimum and maximum results. Also, the distribution of their values is within the normal limits and the group is presented as fairly homogeneous, whereas, in the area of the basketball players' basic and situational motor skills, it is noticed that, even here, the group is homogeneous in all the variables.

Table 3: Basic statistical parameters of the basketball players' anthropometric variables

	N	Min	Max	Mean	Std. Dev.	Skew	Kurt
APESHA	50	47.50	98.00	65.76	10.629	.889	.860
ALARTË	50	155.00	186.00	172.86	.072	-.387	.136
AGJKRA	50	69.00	89.00	79.26	.044	-.083	-.200
AGJEKR	50	153.00	192.00	175.68	.087	-.070	-.092
AGJKËM	50	88.00	112.00	101.04	.051	.065	.090
APEKOF	50	35.00	60.00	50.62	.046	-.381	1.360
APEKËR	50	32.00	44.00	37.02	.025	.753	.321
APEKRA	50	23.00	34.00	26.54	.027	.894	.171

Table 4: Basic statistical parameters of the basketball players' basic motor skills-situational motor skills variables

	N	Min	Max	Mean	Std. Dev.	Skew	Kurt
MKGJVE	50	143.00	270.00	196.62	.295	.681	.128
MHTMSH	50	390.00	790.00	522.00	.980	.844	.251
MHTMUK	50	340.00	755.00	484.32	.956	.889	.548
MV20ML	50	2.50	3.53	3.00	.238	-.068	-.532
MV2x10L	50	7.46	9.80	8.54	.545	.113	-.430
MSD20P	50	7.07	9.54	8.55	.671	-.643	-.641
MSGJLI	50	3.00	5.00	4.50	.580	-.653	-.523
MSGJLM	50	3.00	5.00	4.50	.543	-.396	-1.052
MSGJLD	50	3.00	5.00	4.52	.543	-.479	-.979

Differences in the results of anthropometric variables, basic motor skills and situational motor skills between basketball players and students

Tables 5 and 6 present the values of the T-test through which the differences in arithmetic averages of anthropometric variables and basic and situational motor skills between basketball players and students can be noticed. The differences between basketball players and students in anthropometric characteristics show that no statistically significant differences were obtained for the variables, and that a significant difference between basketball players and pupils in anthropometric characteristics does not exist. Significant differences between basketball players and students are presented in all the basic motor skills, except in the test Standing Long Jump and Medicine Ball Throw (3 kg) from the laying position. Other results show that basketball players have better results in all the basic and situational motor skills variables applied in this paper such as: explosive force of arms, legs, running speed, running front and back. This shows a high level of the active basketball players' basic motor skills, in comparison to the category of students. Also, significant differences between the basketball players and students are presented in motor skills variables starting from the dribbling speed, agility and precision of a basketball shot, in comparison with the students.

Table 5: A T-test in anthropometric area

Group Statistics						Sig.
Groups		N	Mean	Std. Dev.	Std. Err. Mean	
APESHA	Basketball players	50	65.76	10.62	1.50	0.587
	Students	50	64.57	11.25	1.59	0.587
ALARTË	Basketball players	50	1.72	0.07	0.01	0.341
	Students	50	1.74	0.06	0.00	0.341
AGJKRA	Basketball players	50	0.79	0.04	0.00	0.541
	Students	50	0.78	0.04	0.00	0.541
AGJEKR	Basketball players	50	1.75	0.08	0.01	0.819
	Students	50	1.76	0.07	0.01	0.819
AGJKËM	Basketball players	50	1.01	0.05	0.00	0.124
	Students	50	1.02	0.04	0.00	0.124
APEKOF	Basketball players	50	0.50	0.04	0.00	0.677
	Students	50	0.50	0.04	0.00	0.677
APEKËR	Basketball players	50	0.37	0.02	0.00	0.464
	Students	50	0.36	0.03	0.00	0.464
APEKRA	Basketball players	50	0.26	0.02	0.00	0.556
	Students	50	0.26	0.02	0.00	0.556

Table 6: T-test in basic and situational motoric skills

Group Statistics						Sig.(2-tailed)
Variables	Groups	N	Mean	Std. Dev.	Std. Err. Mean	
MKGJVE	Basketball players	50	1.96	0.96	0.04	0.251
	Students	50	1.90	0.23	0.03	0.251
MHTMSH	Basketball players	50	5.22	0.98	0.13	0.006
	Students	50	4.72	0.78	0.11	0.007
MHTMUK	Basketball players	50	4.84	0.95	0.13	0.029
	Students	50	4.46	0.72	0.10	0.029
MV20ML	Basketball players	50	3.00	0.23	0.03	0.014
	Students	50	3.15	0.34	0.04	0.014
MV2x10L	Basketball players	50	8.54	0.54	0.07	0.000
	Students	50	9.56	0.91	0.12	0.000
MSD20P	Basketball players	50	8.55	0.67	0.09	0.000
	Students	50	12.46	3.18	0.45	0.000
MSGJLI	Basketball players	50	4.50	0.58	0.08	0.000
	Students	50	2.72	1.06	0.15	0.000
MSGJLM	Basketball players	50	4.50	0.54	0.07	0.000
	Students	50	2.74	0.96	0.13	0.000
MSGJLD	Basketball players	50	4.52	0.54	0.07	0.000
	Students	50	2.36	1.15	0.16	0.000

CONCLUSION

After processing, interpretation and results analysis of this research, we can conclude that the purpose set at the beginning of this paper was fully realized. The results show that basketball players have better results in the basic and situational motor skills area because there is a direct impact of the trainings performed three times a week at their club. In anthropometric area, it is noticed that the morphological growth and development is the same for basketball players and the students. Finally, we can conclude that trainings have had a positive impact on the establishment of the basketball players' basic and situational motor skills. The same was verified by other authors in their work, when dealing with the comparison between athletes and non-athletes. This once again shows how important sports activity is at the younger ages, not only in development and better growth, but also in development of motor skills, which plays a very important role in performing daily activities.

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RAZLIKE IZMEĐU KOŠARKAŠA I UČENIKA UZRASTA 15 GODINA U NEKIM ANTROPOMETRIJSKIM KARAKTERISTIKAMA I MOTORIČKIM VJEŠTINAMA

Istraživanje je sprovedeno na uzorku od 100 mladih učenika starosne dobi od 14 do 15 godina, u dve škole; prva je bila osnovna škola, a druga su deca iz košarkaškog kluba Prištine. Cilj studije je bio da se dokaže mogućnost razlike između košarkaša i učenika u nekim antropometrijskim karakteristikama, osnovnim motoričkim veštinama i situacionim motornim veštinama. Da bi se definisale ove promene antropometrijskih karakteristika, primenjeno je 18 varijabli za osnovne motoričke vještine i situacijske vještine. Podaci istraživanja obrađeni su deskriptivnim statističkim metodama i putem t-Testa. Rezultati pokazuju da postoje statistički značajne razlike i da postoji statistički značajna razlika između košarkaša i učenika, gdje košarkaši imaju bolje rezultate u svim testovima osnovnih motoričkih i situacionih motoričkih vještina. Rezultati su pokazali da redovno angažovanje dece u košarkaškim školama može poboljšati vještine i znanje mladih igrača i učiniti značajne razlike.

Ključne riječi: antropometrijske karakteristike, osnovne motoričke vještine, košarkaši, studenti, t-Test.

Received: May 15, 2017 / Accepted: June 1, 2017
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KINEMATIC PARAMETERS OF THE COMBINED KICK IN KARATE CONDITIONED BY PHYSIOLOGICAL LOAD

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ABSTRACT

For this study, five respondents-karate athletes, seniors, from the area of the Tuzla Canton (TK), were selected to compete in the fighting. A person representing the model of a karate athlete in this research, who was presented as respondent "A" in the testing, is the multiple World Cup winner (with the initials H. Č.) from KBC "ORKKA" – Lukavac. The other four competitors ("B", "C", "D" and "E") are members of karate clubs from the Tuzla Canton and bearers of medals and winners at cantonal or state competitions. The aim of the research was to determine the differences between the kinematic parameters during a progressive physiological loading for a period of three minutes in the combination of a combined knockout in karate (kizame tsuki-gjaku tsuki & mae geri) between the model and other contestants. As part of the biomechanical characteristics, "Kinovea 2-d Analysis Software" was used to detect kinematic parameters. Heart rate monitoring was performed with the Polar Team system, and the analysis and processing of the data obtained was done using the "Polar Precision Performance 4SW" software package. Based on the obtained kinematic parameters, it can be concluded that the multiple winner of the World Cup (the model) dominates in the speed of hand strikes compared to other competitors, while there is no significant difference in the kick rate. However, it is dominant in the height of the kick performed with the leg supported by maintaining the kicking leg angle between the upper and lower part of the leg. Most importantly, the model, throughout all the zones of the three-minute load progression, has no significant variations in the investigated parameters regardless of intensity increase, while the other competitors vary significantly with the tendency of falling value, especially after half-time or after 90 seconds.

Keywords: kinematic parameters, karate kicks, physiological load, regression.

INTRODUCTION

Karate from the "art of spiritual development" becomes a hobby, a creative activity and in the broadest sense, creative sport (Nešić, 2005), and then suddenly emerges into a personal attractive sport of high achievements. Karate is today a martial art dominated by a kind of force, explosiveness and agility, speed and agility, timeliness, timing and determination. Karate was first practiced as a skill and the trainer was required to show the effectiveness of the technique that reflected the trainer's ability to perform a potentially lethal blow. In a sports contest, this principle was transposed into a rule-of-the-ear equinox - symbolizing the death of the adversary. As the most representative techniques, research studies distinguish the following: stroke with the help of the blood technique of zuki and kizame zuki, as well as the nightingale technique of giza musaši. The percentage representation of the remaining techniques, however, can be considered negligible (Koropanovski and Jovanović, 2007; Mudrić et al., 2004). Kinematic analyses of sports facilities are used multiple times in an effort to make the training process more efficient in terms of achieving as much competitive results as possible. Thus, for example, the performance of each sportsman

can exactly quantify in space and time. Also, if kinematic analyses include ideal motor stereotypes, the obtained results can be treated as modelling. Finally, data obtained by kinematic analyses can serve as a basis for imaginary modelling of motion structures. According to all the aforementioned, the kinematic analysis really becomes a standard within the application of existing technologies designed to efficiently perform the training process (Hraski and Mejovšek 1999). Progressive load is inevitably the accompanying factor both in training and in competition, which is manifested by the athlete's tiredness. In fatigue conditions, there is a significant disruption of joint stability, which increases the risk of injury (Zech et al., 2012). In the background of proper joint stability there is the ability of the nerve-muscular system to quickly and timely correct the wrist position (local nervous-muscular function), as well as the entire body (global nervous-muscular function) in the space (Zech and Sar., 2012; Hübsher and Sar, 2010). By using the Polar Team System, basic statistical indicators based on cardiac frequency tracking are obtained. The heart is no doubt the most important muscle in the body. The function of the whole organism depends on the function of the heart, and through this characteristic the heart points to other important physiological functions. Load can be determined with great accuracy because physiological manifestations can be recorded (Hottenrott, 2006).

THE RESEARCH METHODOLOGY

Sample of respondents

The sample of respondents represents five karate athletes of the senior category from the Tuzla Canton, aged 19-22, with long-standing sports and competition time.

Sample of respondents

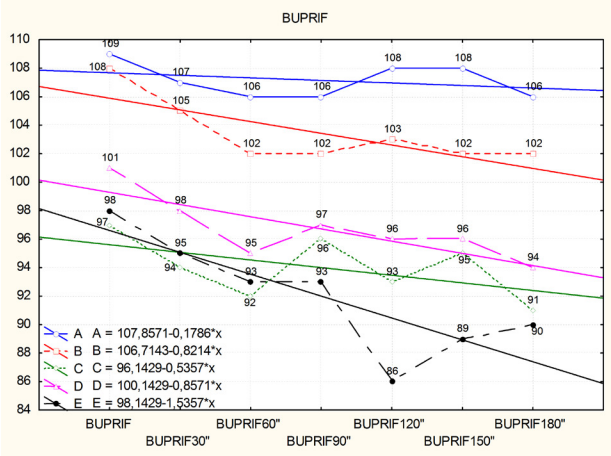
1.first-rate hit rate in the first stage	BUPRIF
2.stroke speed in the second phase	BUZRIIF
3.kick rate of the back in the third stage	BUZNIIIF
4.Hearing height of the back in the third stage	VUZNIIIF
5.The kicking leg angle between the upper and lower part of the leg in the third stage	UNP
6.Heart rate	HR

Research description

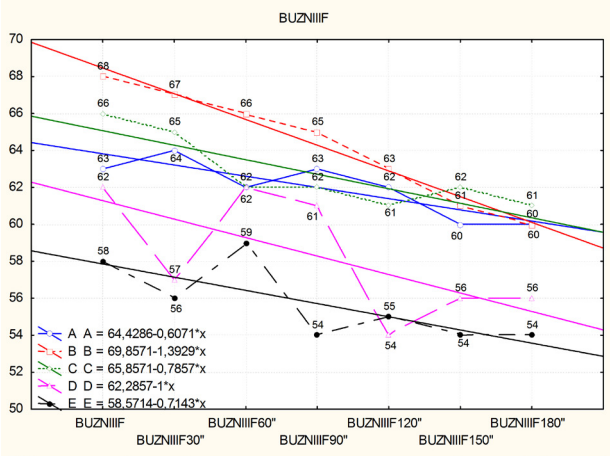
Testing was done in a sports hall with optimal conditions. The combined kickboxing space was bounded by the lines for the starting position individually for each examinee, and the kicks with the hands and feet were directed to the chest of the training doll. The training puppet was moved to the height identical to that of the respondent. Parameter tracking was performed by one respondent performing light locomotor preparation for 10 minutes after fixing the kinematic markers and the heart rate monitor for the detection zone. Then he performed a combined attack - two blows with his hands and one kick - (except tsuki-tsuki blood and mae geri where the attack was performed in continuity, and because of the detection we called it by "phases"). The respondent then returns back to the starting line. After 30 with a repeat attacker, he runs one jump-jump, in the 60s with an attack and a triple jump-jump, an attack in the 90's and six times a jump-jump, an attack on a 120 With a nine-fold kick-off jump, a 150-lead attack, and twelve-fold jump-offs and a 180-second final attack with which the test is over (duration of the fight).

RESULTS AND DISCUSSION

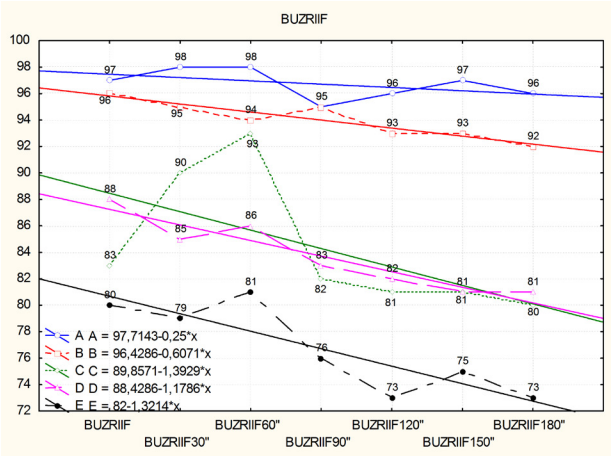
Graphs 1 and 2 show the results of the impact stroke performed using hands detected during the seven measurements, first without load and every 30 seconds after it the progressive physiological load is added. The values are expressed in km / h. In addition to the detection of the results fluctuation, there is a linear regression whose value indicates a decline or increase of the results during all the measurements performed. If the value of the linear regression is equal to 0.00, then it is parallel to the x-axis, which speaks about the equality of results, while the negative or positive sign is about falling or rising over time. Model A respondent (shown in full line of motion values), in both cases, has more value than the other respondents, with a hitting speed of 109 km / h, at the back the hitting speed is 97 km / h on initial measurement (no load) and smaller variations during the course of increasing the physiological load until the end of the test, when it reached the 106 km / h speed with the front hand, or 96 km / h with the back. One competitor had initial values for only 1 km / h less, but at a higher load intensity his regression gained a higher inclination, which is a greater drop in the value of results than the model. The other three competitors have a significantly lower value and a more pronounced drop in the load during the test. It is noticeable that in the model competitor, the linear regression does not have a bigger drop, which is its value with the size of -0.17, while in the other respondents we have a considerably higher value of the regression of the negative sign that identifies the fall of results from the first measurement up to 180.



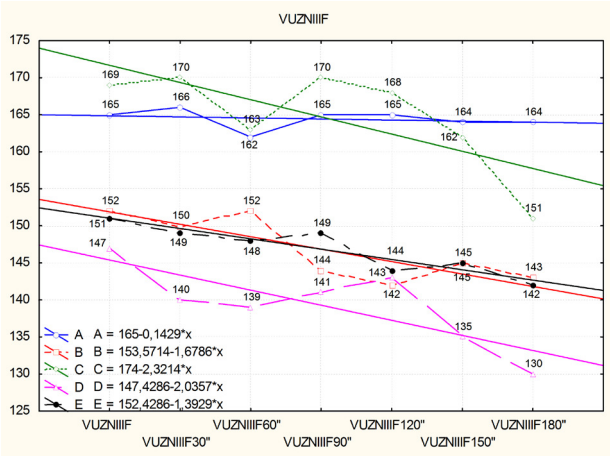
Graph 1: Front impact stroke speed



Graph 3: Footshot Speed



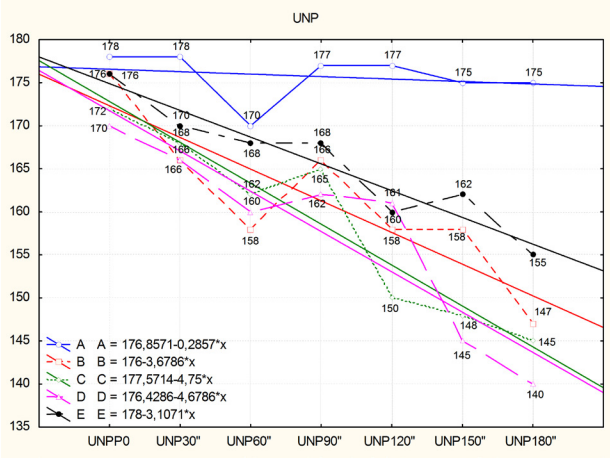
Graph 2: Hitting speed of the back



Graph 4: Foot height

The kick rate of the foot during the performance of the geriatric gait is shown in Figure 3. The height of the kick with the foot is shown in Figure 4 and the values are expressed in cm. Observing the charts we see that two competitors have a higher impact speed than the model, and one of them has a higher kicking height, probably because of the greater body height of the respondent since the aim of the blow was maneuvered at the height of the examinee. In all respondents, a drop in kickback rate is evident, in addition to the magnitude of linear regression with high negative values. Unlike the kick rate of the other respondents, the kick rate in the model did not fall during the increase of the physiological load and has a regression value of a minimum of 0.14, while a greater fall was detected in the third stroke (after 60 s) to keep it continually in higher values.

The kicking leg angle between the upper and lower part of the leg shown in Figure 5 confirms the movement of the stroke height (Graph 4) and is directly related to these values. With fatigue growth, caused by an increase in physiological load, the angle between the segments of the impactor was rapidly reduced, which was a direct reflection of the height of the kick. The model also promotes an angle drop in the 60's and causes a fall in the height of the stroke at a given time to stabilize later and maintain the total regression value with a mild fall and a relatively low value of 0.28 as opposed to other subjects where they were markedly high values of linear regression.



Graph 5: The kicking leg angle between the upper and lower part of the leg

Graph 6 shows the load zones, which are individually determined for each subject, with time on the x-axis and the heart rate values on the y-axis. The first bumps are marked with number 1 (initial-no load) and the other 6 for each next 30 s with the given progressive load. It is noticeable that the respondents moved almost identically across all target zones: from light to maximum intensity. The difference in the model from the others is that the other respondents have already entered the maximum intensity zone in the 150th second, while the model in the 180th second, performing the last attack, was only at the lower limit of maximum intensity. It is interesting that the model had a sudden heart rate drop after the third measurement, i.e. the 60th second, which is most likely to result in a reduced height of stroke and the angle of the upper and lower leg of the impactor, as can be seen in Graphs 4 and 5.

Graph 6: Physiological load zones

The statistical significance of the difference between the kinematic parameters of the model and the other subjects was calculated by means of the linear regression coefficient (Table 1). In the four variables, a statistically significant difference was found in favour of the model, while there was no statistically significant difference in kick rate, where a T-test 2.40 was obtained, and the degree of freedom df = 3 was 3.18 at the significance level of p = .05.

Table 1: T-test of regression coefficients

	Mean	Std. Dev.	nN	Std. Err.	Reference Constant	t-value	df	p
KBUPRIF	0.937475	0.423961	4	0.211981	0.178600	3.579925	3	0.037288
KBUZRIIF	1.125000	0.356575	4	0.178287	0.250000	4.907806	3	0.016197
KBUZNIIIF	0.973225	0.304987	4	0.152494	0.607100	2.400920	3	0.095795
KVUZNIIIF	1.857150	0.406127	4	0.203063	0.142900	8.441950	3	0.003488
KUNP	4.053575	0.798349	4	0.399175	0.285700	9.439163	3	0.002520

Test of means against reference constant (value) case A:
Include cases: B,C,D,E:

CONCLUSION

For a complete diagnosis of the movement technique and adoption of motor skills in athletes, it is especially interesting to know the movement parameters in the performance of the technique, as well as the energy level of the analogous loading zones of the athlete. The same biomechanical and structural characteristics of combined blows are not identical in all the phases of the execution of certain technical elements and must be selectively recorded and analysed for a particularly significant kinematic analysis. Heart rate monitoring during the progressive physiological load detected by the Polar Team system permits an objective approach to intensity in a particular target zone, enabling better programming of the training process. These procedures are particularly important in the competitive sport, because small differences in the performance of motor stereotypes, crucial for the ultimate result, cannot be determined by a visual assessment or subjective experience of athletes and trainers. Based on the obtained parameters in this research, it can be concluded that the multiple World Cup winner, which is the model in this research, dominates in the speed of hand strikes compared to other competitors, while there is no significant difference in the kick rate. However, it is dominant in the height of the kick performed with the leg supported by maintaining the kicking leg angle between the upper and lower part of the leg. Most importantly, the model throughout all the zones of three-minute load progression does not have significant variations in the investigated parameters, regardless of intensity increase, while other competitors vary significantly with the tendency of a falling value, especially after half-time or after 90 seconds.

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KINEMATIČKI PARAMETRI KOMBINOVANOG UDARCA U KARATEU USLOVLJENI FIZIOLOŠKIM OPTEREĆENJEM

Za ovo istraživanje odabrano je pet ispitanika-karatista seniora sa područja tuzlanskog kantona (TK) koji se takmiče u borbama. Kao model karatiste testiran je višestruki osvajač Svjetskog kupa (sa inicijalima H. Č.) predstavljen kao ispitanik „A" iz KBS „ORKKA" - Lukavac, a ostala četiri takmičara ("B", „C", „D" i „E") su članovi karate klubova iz TK, takođe nosioci medalja i pobjednici na kantonalnim ili državnim takmičenjima. Cilj istraživanja bio je da se utvrde razlike kinematičkih parametara tokom progresivnog fiziološkog opterećenja u trajanju od tri minute u izvođenju kombinavanog udarca u karateu (kizame tsuki-gjaku tsuki i mae geri) između modela i ostalih ispitanika-takmičara. U sklopu biomehaničkih karakteristika, za detekciju kinematičkih parametara korišten je „Softver Kinovea 2-d analiza". Monitoring srčane frekvencije vršen je Polar tim sistemom, a analiza i obrada dobivenih podataka izvršena je pomoću programskog paketa „Polar Precision Performance 4SW". Na osnovu dobijenih kinematičkih parametara može se konstatovati da višestruki pobjednik Svjetskog kupa (model) dominira u brzini udaraca rukama u odnosu na ostale takmičare, dok nema značajnu razliku u brzini udarca nogom. Ipak je dominantan u visini udarca nogom što je podržano održavanjem ugla između natkoljenice i potkoljenice udarne noge. Najznačajnije je to što model tokom svih zona progresije opterećenja u trajanju tri minute nema značajnih varijacija u istraživanim parametrima bez obzira na povećanje intenziteta, dok ostali takmičari značajno variraju s tendencijom pada vrijednosti, a posebno nakon polovine vremena odnosno poslije 90-te sekunde.

Ključne riječi: kinematički parametri, karate udarci, fiziološko opterećenje, regresija.

Received: April 25, 2017 / Accepted: May 7, 2017
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THE EFFECTS OF PROFESSIONAL ETHICS ON LEARNING AND INTENTIONAL ORGANIZATIONAL FORGETTING IN STAFF OF YOUTH AND SPORT OFFICES OF ESFAHAN PROVINCE: THE ROLE OF THE KNOWLEDGE SHARING MEDIATOR

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ABSTRACT

The aim of the present study was to investigate the effects of professional ethics on learning and intentional organizational forgetting in staff of youth and sport offices of Esfahan province, considering the mediating role of the knowledge sharing variable. The study domain was Esfahan province. All the subjects were staff of youth and sport offices in Esfahan (N=408), among which a sample was determined to be 260 based on structural equations. For data collection about professional ethics, knowledge sharing, organizational learning and, intentional organizational forgetting variables, standard Cardozier and Brown questionnaire consisting of 16 questions (2004), Dixon questionnaire consisting of 15 questions (2000), standard Gomez, Lorente and Cabreva questionnaire consisting of 16 questions (2005), and standard questionnaire by Moshabaki, Bastam, and Dehyadegari (2013) consisting of 5 questions were used, respectively. Their face and content validity, as well as reliability were confirmed by the professionals` comments and Cronbach`s alpha, respectively. For data analysis, structural equation modelling by Lisrel software was used. The results showed that professional ethics has a positive and significant effect on knowledge sharing, organizational learning, and intentional organizational forgetting, with coefficients 0.83, 0.91, and 0.87, respectively. Furthermore, professional ethics has a positive and significant effect, indirectly by mediation of the knowledge sharing variable on organizational learning with a coefficient of 0.75. Meanwhile, no mediation role for knowledge sharing has been confirmed between professional ethics and intentional organizational forgetting.

Keywords: professional ethics, organizational learning, intentional (strategic) organizational forgetting, knowledge sharing, youth and sport offices.

INTRODUCTION

Ethics is one the most important challenges of human life, because in every organization and profession, behavioural norms and conduct boundaries are determined by ethics which is vital for them. Ethics has religious and mystic origins and is also affected by common law, culture, history and other social phenomena. In fact, there is a continuous interaction between these social phenomena and ethics which makes principles, values and social norms gradually and forms acceptable patterns for personal and social behaviours (MoosaviSirjani and Mansouri, 2016: 257). Ethics is the knowledge

of principles and values about intentional human behaviours and differentiates good and bad, appropriate and inappropriate, and acceptable and unacceptable (Biedenweg, Monroe and Oxarart, 2013: 7). Considering the positive effects of ethics, one of the most important key factors of organizations` success is professional ethics, since more attention to professional ethics in organizations by managers and staff will lead them to achieve the predicted goals (Baegzafaade, Hosseinpor, and Sadeghi, 2010: 5). Professional ethics are rules that should be obeyed in every profession (Sultana, 2014: 44). In other words, they are standards of human conduct that determine the behaviour of people and groups. In fact, the aim of the rational thinking process is to determine organizational values, and lack of attention to this topic in organizations will question their legitimacy and measures by professional ethics codes (Arasteh and Jahed, 2011: 7). Codes of professional ethics are sets of written instructions from organizations for staff and managers in order to help them do their measures based on organizational standards and values (Sultana, 2014: 45). Thus, professional ethics provides a framework by editing codes of ethics that can be a guide for answering questions related to ethics growth and development (FarajKhoda, Latifnejhad, and abbasi, 2012: 43).

In a knowledge-centred economy, intangible assets of organizations are increasingly turning into a determinant competitive factor. These assets like commercial brands, popularity of the company, skills and technical knowledge of staff are considered as the core of competitive advantage (DanaiFard, Khaefollahi, and Hosseini, 2012: 63). Among these, the only identified asset increased by sharing and its distribution, which helps its growth, is knowledge (Kazemi, VahidiMotlagh, and VahidiMotlagh, 2015: 108). One of the main purposes of managers in organizations in using knowledge management is improving knowledge sharing between staff, since effective knowledge sharing between members of an organization decreases costs of knowledge development and guarantees distribution of the best method in the organization and helps the organization to manage problems and challenges (DanaiFard, Khaefollahi, and Hosseini, 2012: 64). Knowledge sharing means sharing organizational related data, ideas and thoughts, recommendations and experiences of staff together and accessibility of knowledge in the organizations for others (Smith, 2012: 5). Knowledge Sharing is a new research area that has helped researchers in conceptualising different kinds of knowledge sharing in organizations (Salimi, Sabaghyan, Danaeefard and Abolghasemi, 2011: 52). Factors that facilitate and encourage knowledge sharing among staff must be determined (Rahnavard and Sadr, 2009: 52), and human resources seems to be one of these effective factors. Observance of ethical considerations by human resources helps better providing of knowledge management (Rezaian, AhmadVand, and Toolai, 2011: 205). Professional ethics has a vital role in developing, maintenance, sharing, and using knowledge; thus, at first, managers and staff should equip themselves with the newest scientific findings and then try to distribute and teach them to others by using professional ethics (Malkami and Behrouz, 2015: 15). Based on Numan general model, it can be said that there is a positive and significant relationship between ethical indices and knowledge and experience sharing (Rezaian, Ghazi nori, 2010: 68). Studies by Qorbani (2012) and Amiri (2015) also showed that professional ethics of staff can increase their participation in knowledge sharing in organizations.

In an environment, the main indicator of which is knowledge and technology development, methods of knowledge acquisition lose their traditional form and become more modern. These situations transform the present environment to a competitive and challenging one and request new paradigms. In new paradigms related to organizational knowledge, the biggest competitive advantage is learning ability. So, organizations that learn faster and better than others will succeed. Because of this, an increasing growth in research related to organizational learning is observed in recent years (HajuPour and Kashani, 2011: 182). Organizational learning is a process of organizational actions improvement by better knowledge and cognition (Skerlavaj, Song, and Lee, 2012: 392) in order to form mind patterns for members of an organization by sharing different insights and based on existing knowledge and experience in memory of the organization (Hosnavy and Ramezan, 2012: 3). Organizational learning is a topic which has a role in survival of an organization and its success in a competitive field (Martinez and Martinez, 2011: 539).

Knowledge sharing, as one of the dimensions of organizational learning, causes knowledge acquisition and developing new ideas in an organization (Ardalan, BeheshtiRad, and SoltanZadeh, 2017: 26). Mason (2011) believes that organizational learning develops a positive environment for improvement and advancement of knowledge management processes in organizations and organizational learning is a key factor for knowledge management success. A careful look at knowledge management and its purposes shows that knowledge management and organizational learning are in a close relationship, in a way that improving and development of every one of them improves the other. The relationship between knowledge

management and organizational learning is such that some professionals state that the final goal of knowledge management is organizational learning (Daneshmand, 2015: 1). Since the code of ethics in every organization is formed by participation of all managers and staff, it is considered as a general convention and these principles will gradually become a part of organizational goals. In fact, encouraging ethics in the organization means a special kind of organizational life (fassin, 2005: 125). One of the barriers for learning ethics in an organization is a delay in organizational revolution toward a learner organization (Gharamaleki and Sayari, 2008).

In today`s world, sport organizations are facing a vast range of useful and non-useful data which are not capable of being stored in organizational memory; they stop organizations from moving forward, so it is necessary to remove and delete non-useful data from organizational memory; in other words, organizational memory should be prepared for learning new and necessary knowledge and data by strategic (intentional) organizational forgetting (JalaliFarahani, Saberi, and Javid, 2016: 39). Intentional organizational forgetting alludes to measures by an organization to facilitate forgetting unnecessary data and prevent deleting of useful data (Moshabaki, Bastam, and DehYadegari, 2013: 94). In other words, intentional organizational forgetting occurs in two situations. In the first one, managers intentionally delete knowledge which prevent changes in the organization. In the second one, managers identify potentially harmful knowledge and prevent it from being added to current knowledge in the organization. In both of them it is an intentional process which is managed by companies (JalaliFarahani, Saberi, and Javid, 2016: 37). Modern organizations should be able to learn new knowledge that is called organizational learning and should be able to control present knowledge; in other words, while preventing useful data from being destroyed, they must be able to delete and ignore a part of stored knowledge which is called intentional organizational forgetting (Moshabbaki, Bastam, and DehYadegari, 2013: 104). The most important factors in the forgetting process in an organization are inability to acquire and distribute learning in the organization, not utilizing knowledge acquired by learning, inability to participate in coding and documentation of knowledge and lack of motivation for its sharing (AliMohamadi, 2012: 11). Jiang and Qiang (2010) in their study, the relationship between intentional organizational forgetting and organizational innovation with mediating effect of organizational learning ability, suggested that intentional organizational forgetting is a vital element in knowledge management. Managers should increase their organizational knowledge management capacity in order to improve organizational function; and this will not happen unless the organizational forgetting learning process is executed more dynamically and more effectively (Moshbbaki, Bastam, DehYadegari, 2013: 93). Organizations have to use knowledge management for learning new knowledge and maintain the current one in order to improve their competitive position. Organizational learning and organizational forgetting are the two main dimensions of knowledge management for acquiring competitive advantage in organizations. On the other hand, considering the importance of sports in society, it can be seen that there is lots of problems in using knowledge in sports organizations for their issues; and considering close competition for adapting new and up-to-date knowledge they should ignore their old knowledge and replace it with the new one (Eidi, BakhshChenari, and Abbasi, 2015: 14). Khezr Zadeh (2014) suggests human resources as the most fundamental resource of every organization. In fact, staff are the present and future determinant of every organization`s education, industry, politics and economy. Knowledge and skill are the most important abilities every manager wishes the staff have. Managing knowledge and skill is an important challenge of every futuristic manager. When a person in an organization forgets his knowledge and skill intentionally or uses intentional organizational forgetting, it shows that professional ethics has led to intentional organizational forgetting. A study by Binesh (2012) indicated that there is a significant relationship between professional ethics and intentional organizational forgetting.

Professional ethics has become more prominent in organizations these days and has a vital role in maintaining and sharing knowledge, so that lack of attention to it has a huge amount of expenses for the organization. It is also effective on organizational learning and forgetting, of which few studies are available. Since knowledge is very important and currently there is a big competition for its sharing among organizations, organizational learning is also considered, because there is a close relationship between knowledge and organizational learning. However, the importance of organizational learning has recently been clear and there are a few studies in this regard. It is obvious that for increasing knowledge and organizational learning, organizations are faced with a huge amount of data, among which intentional organizational forgetting by deleting old and useless knowledge from organizational memory would be helpful. However, there are a few studies available on intentional organizational forgetting. Thus, the present study aims to investigate the effect of professional ethics on strategic organizational learning and forgetting of staff of Youth and Sport offices in Esfahan province, considering the mediating effect of knowledge sharing. In other words, the purpose is to study the effect of considered factors on Esfahan`s Youth and Sport offices` function that is illustrated in a model in figure 1.

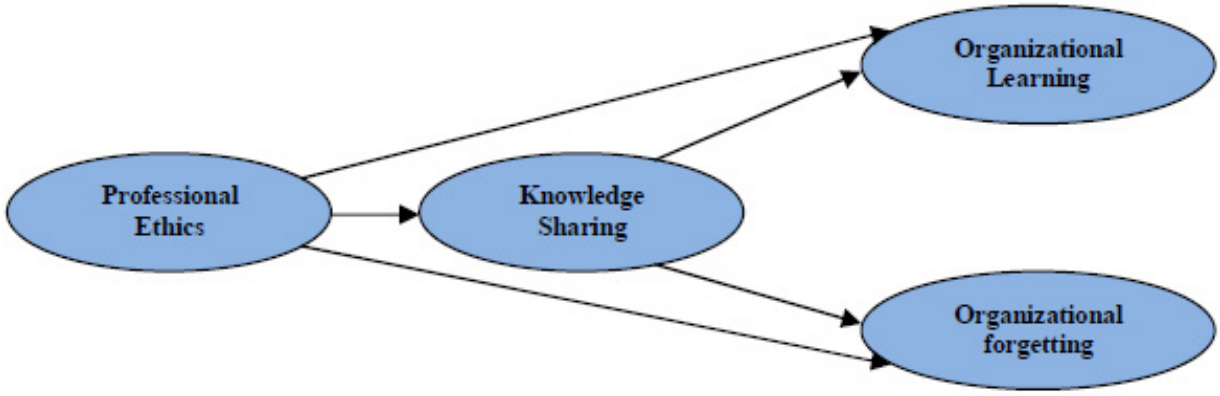

Figure 1: Conceptual model

METHOD

The method of the present study was applicable, from the purpose point of view, the scientific type, in which the collection of data was carried out in the field. The study domain was Esfahan province and all the subjects were staff of Youth and Sport offices in Esfahan, which has been estimated to be 408, in spring of the year 2016. The sample size calculated by Krejcie and Morgan table was determined to be 201. However, since in structural equation studies, the sample size should be five times the number of questions in questionnaire (Abdolmaleki, Rashidi, 2013), the sample size was increased to 260. For sampling, a random classified method was used according to geographical distribution of subjects in the province and their sexuality. In the conceptual model of the study, professional ethics was considered as independent variable and knowledge sharing, organizational learning, and strategic organizational forgetting variables were considered as dependent variables.

For data collection, about professional ethics variable, a standard 16-question questionnaire Cardozier and Brown (2004) was used which included 8 elements with 2 questions, responsibility, honesty, justice and fairness, loyalty, excellence and competitive, respect for others, sympathy, respect for values and social norms. Data collection about knowledge sharing variable was carried out by standard Dixon (2000) questionnaire which has 15 questions in 4 elements, educational knowledge (3 questions), obvious knowledge (5 questions), hidden knowledge (3 questions), and strategic knowledge (4 questions). For data collection about organizational learning variable, standard questionnaire of Gomez, Lorente and Cabreva (2005) was used which includes 16 questions in 4 elements of management commitment (5 questions), systemic view (3 questions), open and experimental environment (4 questions), and knowledge integration (4 questions). Finally, the standard questionnaire of Moshabbaki, Bastami, and DehYadegari (2013) including 5 questions in two elements of de-learning (3 questions) and avoiding bad habits (2 questions) was used in data collection for the strategic organizational forgetting variable.

Each of the questionnaires used in this study was standard, the reliability and validity of which had been confirmed in several studies. However, the comments given by 10 professionals and Cronbach's alpha based on a group of 30 were used for re-evaluation of face and content validity and reliability, respectively; it is shown in table 1.

Table 1: Cronbach's alpha of variables

Variable	Professional ethics	Knowledge sharing	Organizational learning	Strategic organizational forgetting
Cronbach's alpha	0.83	0.92	0.87	0.90

For data analysis, structural equation modelling was used in LISREL software 8.80.

FINDINGS

Diagram 1 shows the structural equation model of the study in standard. In this model, 4 latent variables, professional ethics, knowledge sharing, organizational learning, and strategic organizational forgetting, are supported by 18 obvious variables (their elements).

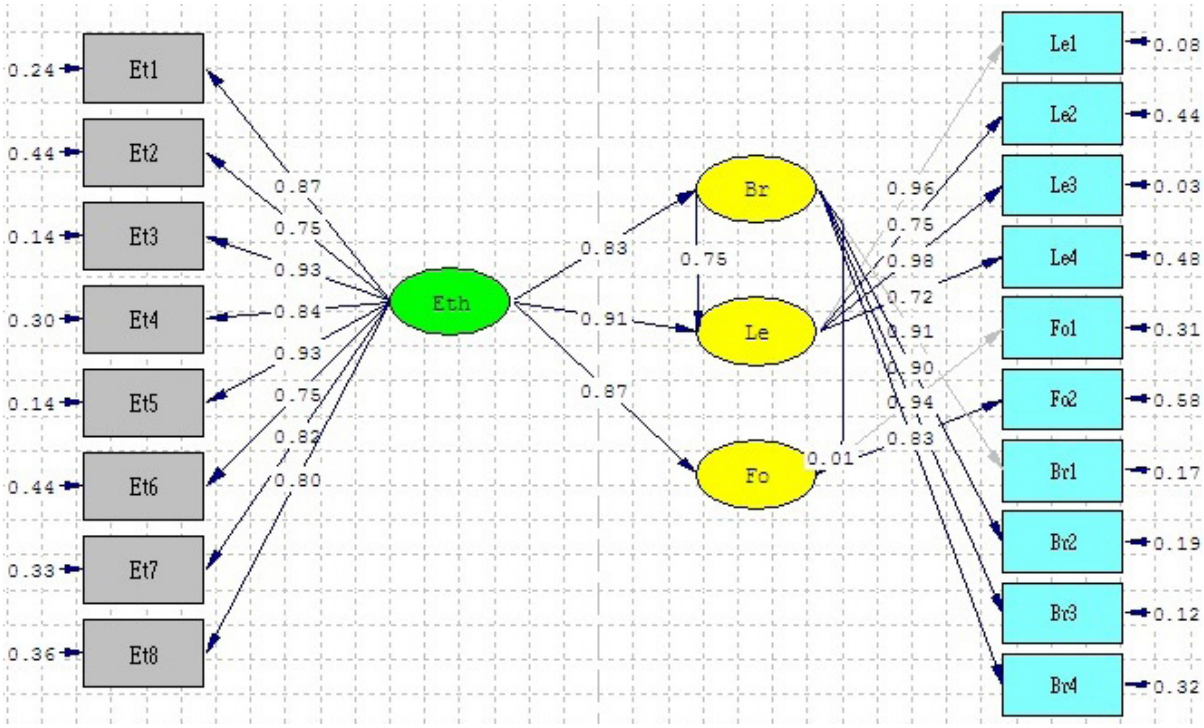

Diagram 1: standard structural equations model

Table 2 shows indices related to validity of the model resulted from data analysis based on the structural equations model.

Table 2: Indices related to validity of model

Index	Value	Accepted range (Abdolmaleki and Rashidi, 2013)
X^2/df	1.93	<2
RMSEA	0.071	Accepted error <0.08
RMR	0.067	Closer to zero, more valid
GFI	0.95	>0.9
AGFI	0.93	>0.9
PGFI	0.73	>0.5
NFI	0.95	>0.9
CFI	0.96	>0.9

The results in table 2 indicate that the provided model is appropriate. Moreover, for investigating significant relationship between latent variables, as well as latent and obvious variables, a T-value was used (Diagram 2).

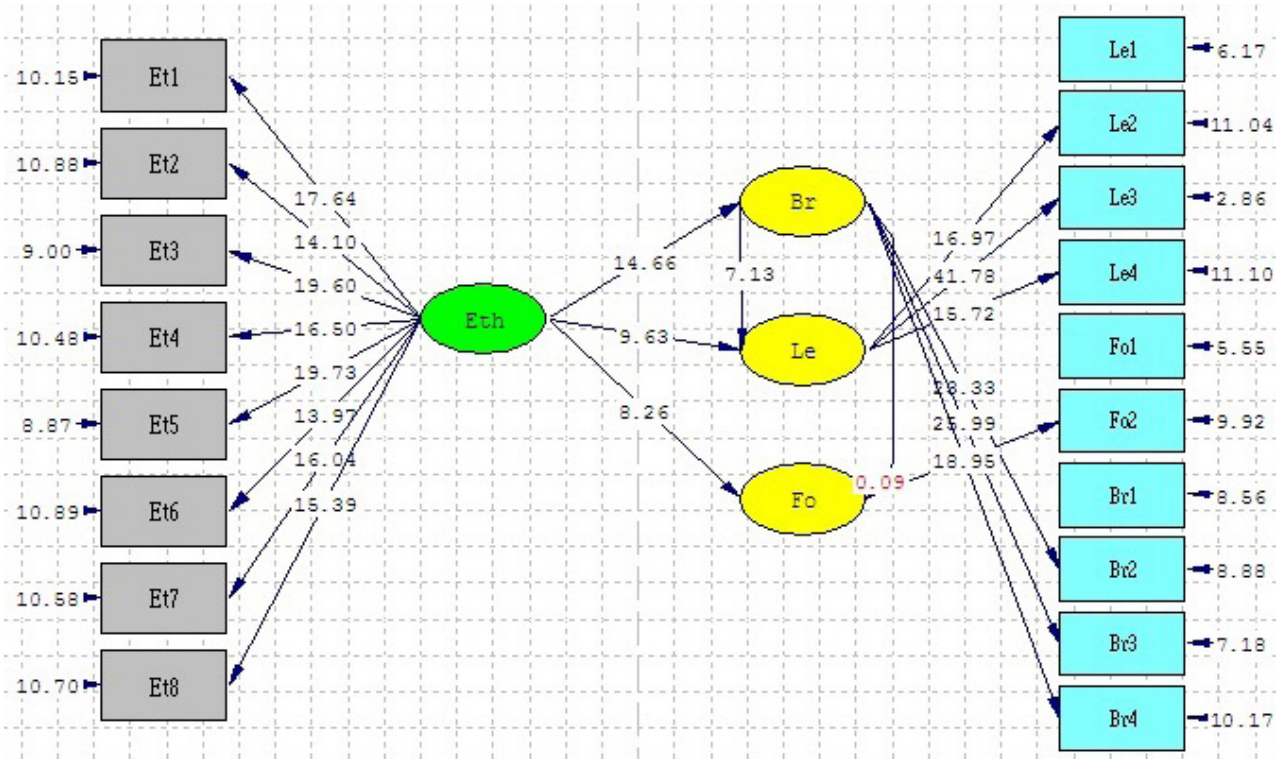

Diagram 2: Structural equations model in T-value

As it is shown in diagram 2 and structural equations model, all obvious variables support related latent variables appropriately. Furthermore, the effect of knowledge sharing on strategic organizational forgetting was not significant, however, the effect of other latent variables were significant. Finally, the structural model of the study was indicated in diagram 3.

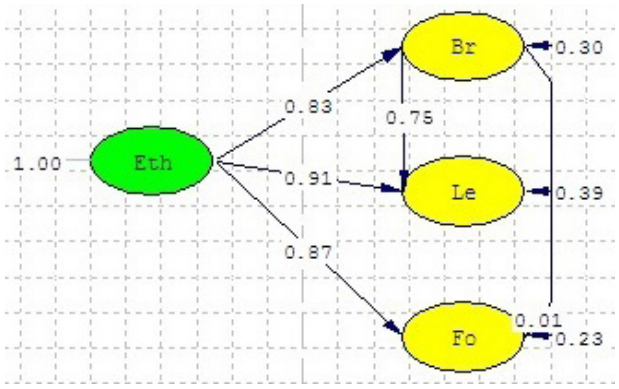

Diagram 3: Structural model

As it can be seen in diagram 3, there is a positive and significant effect of professional ethics latent variable on knowledge sharing, organizational learning, and strategic organizational forgetting latent variables, with a coefficient of 0.83, 0.91, and 0.87, respectively. Also, professional ethics has an indirect positive and significant effect, by the mediating role of knowledge sharing, on organizational learning with a coefficient of 0.75. Although the coefficient has decreased from 0.91 to 0.75, the role of knowledge sharing is confirmed. Meanwhile, this role has not been confirmed in the relationship between professional ethics and strategic organizational forgetting. Table 3 shows the effect of latent variables based on a predetermined relationship in a conceptual model of study.

Table 3: Standard coefficients in a structural model

Path	Type of path	Standard coefficient	Result
Professional ethics to organizational learning	Direct	0.91	Effective (Confirmed)
Professional ethics to organizational forgetting	Direct	0.87	Effective (confirmed)
Professional ethics to knowledge sharing	Direct	0.83	Effective (confirmed)
Knowledge sharing to organizational learning	Indirect	0.75	Effective (confirmed)
Knowledge sharing to organizational forgetting	Indirect	0.01	Ineffective (not confirmed)

As it is obvious, the conceptual model of the present study was confirmed in all but one, the mediating role of knowledge sharing in the relationship between professional ethics and strategic organizational forgetting. (In other words, there is no significant effect of knowledge sharing on strategic organizational forgetting).

DISCUSSION

The final goal of the present study was to investigate the effect of professional ethics on strategic organizational forgetting and learning in staff of Youth and Sport offices of Esfahan province, considering the mediating role of knowledge sharing. Regarding this aim, the results showed that professional ethics has a positive and significant effect on knowledge sharing with a coefficient of more than 0.83, which is consistent with the results from Noorani (2012), Akhavan and YazdiMoghaddam (2013), Rezaian, Ghazi nori (2010), Tseng and Fan (2011), Khurram Zafar, Mehwish (2012), and ShabgooMonsef, Fadaei and Afshin Pour (2014). Noorani (2012). Studying the relationship between professional ethics and knowledge sharing among university managers, suggested that there is a significant relationship between professional ethics and knowledge management. Akhavan and YazdiMoghaddam (2013), also pointed to a positive and significant relationship between ethics and knowledge management process and discussed that paying attention to ethics by human resources helps better implementation of knowledge management. So, it can be concluded that professional ethics is a key factor for an organization`s success which is achieved by encouraging and paying attention to knowledge acquiring that is the most important investment and competitive factor in todays` world. Rezaian and Ghazi Noori (2010) also confirmed the role of professional ethics in knowledge management success in their modelling research. Based on the results of this study and Numan general model, it can be said that professional ethics in the organization will improve staff function and participation in the knowledge management process and put the focus of organizational knowledge management on knowledge sharing as one of the most important dimensions. Tseng and Fan (2011) say that knowledge management is one of the variables that can be predicted by organizational ethic environment. In this regard, Khurram Zafar and Mahwish (2012) believe that considering the person, knowledge sharing depends mostly on personal characteristics. If professional ethics is accepted by all the staff, they will share their knowledge with each other. ShabgooMonsef, Fadaei and Afshin Pour (2014) also suggested that different ethical environments in the organization, have different effects on staff participation in knowledge sharing activities. Another result showed that knowledge sharing has a positive and significant effect on organizational learning with the coefficient of 0.75. Moshabbaki, Bastam, and DehYadegari (2013), in a study to improve organizational performance through intentional organizational forgetting, concluded that intentional forgetting and organizational learning are effective organizational performance by improving knowledge management improvement. The results of a study by Perez (2010) showed that there is a mutual and significant relationship between knowledge management processes and organizational learning. So it is concluded that knowledge distribution needs a learner environment and these two variables are in close relationship. In this regard, Gorelick in his study (2011), knowledge management vs. organizational learning, said that organizational learning and knowledge management can and should combine, and for a learner organization`s efficacy there is a need for a deep learning chain associated with knowledge and data in the organization. Jadid, AlamZadeh, MohammadiPirasteh, HoseiniPak, and Mirzai (2013) in a study, relationship between knowledge management and organizational learning levels, concluded that there is positive and significant relationship between knowledge management and organizational learning levels. Also, during knowledge sharing interactional processes, personal knowledge gradually transforms to organizational knowledge and absorbance capacity will increase, in a way that the higher the level, the more ability of an organization in production, learning and using new knowledge will be (Nadi, Bakhtiar Nasr Abadi, and FarahmandPour, 2012: 126). So, it is suggested that organizational learning is a strategic variable for the organization because the organization has to increase its learning capacity to have advantages compared to competitors, and this will happen if the knowledge chain moves faster and knowledge sharing takes place better, in order for the organization to adapt to changes and overtake rivals.

The other result is the positive and significant effect of professional ethics on organizational learning with the very high coefficient of 0.91. In this regard, Fathollahi, Zarei, and Azadi (2017) believe that professional ethics has a direct positive effect on organizational learning, which is consistent with the results of the present study. It can be said that the mediating role of knowledge sharing in a relationship between professional ethics and organizational learning is positive and significant. It means that a professional effect has a direct and an indirect effect on organizational learning. If more attention is paid to professional ethics by managers and staff, they feel more committed and there will be higher level of learning and improved performance and efficacy in the organization.

However, in the present study, the effect of knowledge sharing on intentional organizational forgetting has not been confirmed, which is not consistent with the results of studies conducted by PoorHatami, ZareiMatin, Hayati, and Atai (2016), and HajiAzizi, Esmati, and Moradi (2010). PoorHatami, ZareiMatin, Hayati, and Atai (2016). In a study to investigate the effect of intentional and unintentional organizational forgetting on the learning process, they concluded that there is a relationship between intentional organizational forgetting and knowledge sharing, knowledge performance, and results revision. Furthermore, HajiAzizi, Esmati, and Moradi (2010), in a study titled organizational forgetting: a novel approach in knowledge management, quoted from Hulan and Philips (2003) that organizational forgetting has this potential to add a new and important dimension to our understanding of organizational knowledge dynamicity. Thus, by forgetting a part of knowledge without using an organizational memory chain, knowledge can be shared and knowledge performance can be improved.

Out of other results, there is the effect of professional ethics on intentional organizational forgetting with the coefficient of 0.87, which is consistent with the results of the study conducted by Binesh (2012), who suggested that some errors made by the staff (intentional forgetting) are caused by the manager`s ethical attitude. The mediating role of knowledge sharing in effect of professional ethics on intentional organizational forgetting is not positive and significant. Considering that professional ethics has a positive and significant effect on knowledge sharing, and knowledge sharing has no positive or significant effect on intentional organizational forgetting, it can be concluded that there is no indirect effect of professional ethics on intentional organizational forgetting.

Generally, considering the confirmation of the mediating role of knowledge sharing between professional ethics and organizational learning, it can be said that Youth and Sport offices in Esfahan province can respond to environmental changes and costumers` needs by encouraging professional ethics among staff and providing an appropriate place for organizational learning and focusing on knowledge sharing; and these are competitive advantages that lead to success and efficacy.

In conclusion, although the results of this study can be helpful for managers to better understand the mediating effect of knowledge sharing in professional ethics with organizational learning and intentional organizational forgetting, it seems that the method to apply these results in practice needs more work. Also, it is recommended that other researchers carry out this research considering the relationship between organizational forgetting and learning. Because, among available studies, it was concluded that theorists define organizational forgetting as a learning change and a relearning process in organizational memory, the intentional process for leaving memory and reconstruction, and a vital component of an organization (Jiang and Fu, 2010: 2). Regarding the results, it is recommended that for improving knowledge sharing in Youth and Sport offices of Esfahan province, groups for encouraging team work in the organizations should be formed. Encouraging learning and teaching among staff that leads to knowledge sharing in the organization and holding organizational learning workshops for staff are other recommendations.

It is worth mentioning that the present study, like other studies, faced limitations. One of them was related to bias of subjects answering the questions, since the basic method of data collection was questionnaires.

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EFEKTI PROFESIONALNE ETIKE NA UČENJE I NAMJERNO ORGANIZACIJSKO ZABORAVLJANJE KOD OSOBLJA UREDA ZA MLADE I SPORT U POKRAJINI ESFAHAN: ULOGA POSREDNIKA ZA RAZMJENU ZNANJA

Cilj ovog istraživanja jeste proučiti efekte profesionalne etike na učenje i namjerno organizacijsko zaboravljanje kod osoblja ureda za mlade i sport u pokrajini Esfahan, uzimajući u obzir posredničku ulogu varijable razmjene znanja. Područje istraživanje je bila pokrajina Esfahan. Ispitanike je sačinjavalo osoblje ureda za mlade i sport u Esfahanu (N=408) među kojima se utvrdio uzorak od 260 osoba na osnovu strukturnih jednačina. Za prikupljanje podataka o profesionalnoj etici, razmjeni znanja, organizacijskom učenju i varijablama namjernog organizacijskog zaboravljanja, koristili su se standardni upitnik Cardozier and Brown koji se sastoji od 16 pitanja (2004), Upitnik Dixon koji se sastoji od 15 pitanja (2000), standardni upitnik Gomez, Lorente and Cabreva koji se sastoji od 16 pitanja (2005), te standardni Moshabaki, Bastam, and Dehyadegari upitnik (2013) koji se sastoji od 5 pitanja. Njihova pojavna i sadržajna valjanost, kao i pouzdanost je potvrđena komentarima profesionalaca i Cronbachalpha koeficijentom. Za analizu podataka koristilo se modeliranje strukturnih jednačina putem Lisrel računalnog softwarea. Rezultati su pokazali da profesionalna etika ima pozitivan i značajan efekat na podjelu znanja, organizacijsko učenje i namjerno organizacijsko zaboravljanje, sa koeficijentima 0,83, 0,91, i 0,87 respektivno. Nadalje, profesionalna etika ima indirektan pozitivan i značajan efekat putem posredovanja u varijabli razmjene znanja organizacijskog učenja sa koeficijentom 0,75. Međutim, za profesionalnu etiku i namjerno organizacijsko zaboravljanje nije potvrđena posrednička uloga razmjene znanja.

Ključne riječi: profesionalna etika, organizacijsko učenje, namjerno (strateško) organizacijsko zaboravljanje, razmjena znanja, uredi za mlade i sport.

Received: February 6, 2017 / Accepted: February 21, 2017
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VIOLENT BEHAVIOR OF YOUNG ATHLETES TOWARDS OTHER ACTORS IN SPORTS EVENTS

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ABSTRACT

This paper describes the attitude of young athletes towards other participants in sport events. The subject of this research was the relationship as a phenomenon that represents a social dimension that makes every sporting event. The aim of the research was to analyse the relationship observed in sports through the attitudes of young athletes in certain situations during the contest. The study aims to determine the relationship that young athletes have with their teammates, opponents, judges and the audience.

Keywords: athletes, sport, sports events, competition, relationship.

INTRODUCTION

The development of modern society includes a series of changes even in contemporary sports. The fast pace of life, orientation toward success and a different system of values, are just some of the circumstances that enable the identification of the modern sports transformation process. Contemporary sports is a complex area of society that includes positive and negative elements. The imperative of success represents a driving motivational force that imposes certain negative behaviours as legal means in the way to achieving goals. The pressure that athletes feel before each important competition represents the destructive element of the game, where athletes deliberately cross the border of ethics and fair play in order to fulfil certain expectations (coaches, teammates, parents, audience and personal).

Sport in its historical development has always relied on fair play as an important pillar of ethical development of society. Fair play originated in the UK, from where it is transferred to Europe and other parts of the world. Pierre de Coubertin in France was among the first to have eagerly embraced a new way of behaviour in sports (Renson, R. 2009). Contemporary sport imposes the trend of early sports on the principles of intensive work, with the aim of achieving the earliest significant results. Therefore, it often happens that sports coaches and parents carry out a certain kind of pressure on young athletes wanting to achieve their ambitions at the expense of proper psychosomatic development of the child through play. Leaving the principles of the game and orientation towards professional approach to training and matches puts additional pressure on young athletes. This is one of the reasons why there is presence of tension, frustration that often transform into violent behaviour in competitions. Another negative factor is the learning pattern based on the behaviour of older athletes whose negative reactions and behaviour have an alibi in the professional demands and expectations of the sponsors, owners and the like.

THEORETICAL CONSIDERATIONS

Sport allows athletes to express themselves and to bring out their personal traits. It can be a place of human victory, glory, but also the place of degradation, dehumanization, violence (Kozarčanin, 2008).

Sport is of great significance for young people, both in health, and in educational, social and psychological sense. Sport allows meeting the children's need for playing, socializing and entertainment. Sport

strengthens the character of young people and enables them to become more resourceful and capable with the acquisition of certain skills and habits. The importance of sport is reflected in its role in the integral development of the personality. This is why many psychologists are interested in research in the field of sports and physical culture.

Much of the research conducted in the field of sport and physical education pointed to the connection between motor and intellectual aspect of personality (Ismail et al., 1967, 1972; Momirović, et al. 1980, 1981, 1982). This research confirms the concurrence of researchers around the claim that the observation of the human personality must be based on an integrated basis. The results of research conducted by Ismail and associates prove a positive influence of systematic physical exercise and results in tests of school knowledge (Lazarević, 2001).

Young people are aware of the importance of sport and this is proven by research conducted among students of primary school with regards to their attitude towards sporting. The study results show the dominance of a positive attitude towards sports (61.65%) in comparison to the presence of moderate (15:29%) and negative (23.6%) students' attitudes (Milošević et al. 2016).

Their general attitude about sports and sports activities is positive, with the presence of a certain percentage of negative attitudes about sports for different reasons. It would be interesting to conduct a research on the reasons for negative attitudes about sports and their justification.

The research results of another group of authors, conducted among students, showed that in 65% of respondents, health is pointed out as the most important value. Interestingly, further analysis shows that out of the 65% of students that list health as the most important value, only 36% engage in some kind of physical activity, while 64% have no physical activity. The study also found that young people who were surveyed, do not see any link between health and physical education, they are obviously not thinking about the fact that it is necessary to maintain health. Research has further shown that a large percentage of respondents have listed good physical appearance (33%) among the most important factors of life. 44% of these respondents is engaged in some kind of physical activity, while 56.4% neglects physical activity, which is among the most important factors for maintaining a good physical appearance. The respondents' answers indicate that modern young people do not see the connection of physical fitness for the job and engaging in physical activity, while 38% of them practiced some form of physical activity. 76% of students consider to adhere to a healthy lifestyle. More than half (53.8%) engaged in some kind of physical activity, 46.2% does not engage in any physical activity. These data suggest that, for a large number of respondents, "a healthy lifestyle" does not involve physical activities. (Kastratović, et al, 2016).

In addition to positive effects, in contemporary sports certain forms of violent behaviour often occur, as a result of some excessive and unrealistic expectations. One of the main factors that influence the occurrence of violent behaviour in young athletes is anxiety. On the one hand, anxiety in sports emerges as a conflict between, desires, needs, and expectations of success, and on the other hand anxiety, discomfort, fear of failure to succeed and consequences (Lazarević, 2001).

Social relations of youth in sports

Young athletes who are actively involved in sports every day are faced with various forms of social interaction through training and matches. Sport is a dynamic environment that initiates frequent social expression in the cycle of acquiring sports skills and its demonstration in the context of competitive stages. Relations between young athletes are intertwined with influences of internal and external factors. The psychosomatic status of every child significantly affects his behaviour in daily sports activities. Emotions, building attitudes, wishes and needs, personal experience and physical maturity, are some of the internal factors that influence the behaviour of young athletes in a number of specific situations that can occur in the course of competition. Aggressive behaviour of young athletes may be a reflection of the influence of external factors: family, society, media, social status, stress and the like. Violence in sports is nothing new but is more widespread among young people. There are different forms of violence, where according to age periods, certain forms of violent behaviour are more common than others.

At the very beginning, violence appears in the form of seemingly innocent uncharted verbal conflicts, and then gradually, through other forms of violence, it turns into aggression. In the beginning, teasing is pronounced, as well as provoking, swearing, pushing, punching, and later it turns into more severe acts of physical and psychological violence (Popadić, 2011).

Sometimes the cause of violent behaviour in young athletes is linked to certain forms of the individuals' pathological condition. With neurotic athletes there are specific behaviours. They have a problem with a systematic type of exercise, it is more difficult for them to sustain competition and they come into conflict easier and more often (Mladenović, 2005).

Verbal Violence

Verbal violence is the act of aggression by an individual or group towards other individuals or a group expressed through words. Insulting represents the basis of verbal violence. Through verbal violence, certain messages with the aim of inflicting mental pain are transferred. Verbal violence is different from case to case in accordance with the content of violence, as well as the degree of emotional involvement of the person who carried out the violence.

The specificity of verbal violence is that it leaves no visible traces, so it is very difficult to prove. The probability of verbal violence is reduced to witness testimonies on acts of violence, as well as video or audio recordings (in case that the area is covered by technological support).

Verbal violence is present in sports. The degree of violence and the frequency depend on the type of sports activity, athlete character traits, family education and acquired patterns. Young athletes find their role models in coaches, parents and older athletes. Parents who want success and those who are quite contaminated knowing about the astronomical salaries in professional sports, often use verbal violence directed towards the judge, opposing coach or other athletes. Such behaviour patterns have a negative effect.

PREVIOUS RESEARCH

In a study conducted in 2011 as part of the project of the Ministry of Youth and Sports and the Center for Children's Rights, it was observed that verbal violence is the most widespread form of bullying. Survey data show that 24-29% of teenagers and 30 to 32.5% of older athletes experienced verbal abuse in sports. It is also interesting that 11.3% of athletes (both men and women alike) have experienced verbal abuse from teammates. It is also noted that older athletes (ages 16-17) are significantly more often the victims of teammate violence than the younger ones. It has also been recorded that there have been instances of violence towards the opponent, the athletes state that they have mocked, invoked and debased other athletes (19.8%) and judges (17.5%), (Popadić, et al., 2011).

The survey which was conducted among young football players in Zagreb focused on violent behaviour among young people. Questions focused on personal experience of the athletes, and the presence of violence among the other athletes. The highest percentage of athletes had experienced violence from other athletes during the matches (23.5% frequently, 36.8% occasionally). Next is swearing, where the number of answers "sometimes" and "often" was 46% and, at the end, insults about 34%. The research also included coaches of the mentioned population of young football players, who presented their experience from the matches. Coaches have confirmed that there is verbal abuse among athletes, with answers "sometimes" accounting for 25.8% and "often" 3.2%. They also confirmed that athletes shout at each other, where "sometimes" amounts to 41.9% and "often" 9.7%. Athletes have also used belittling, with "sometimes" amounting to 29% and "often" 3.2%, while insults accounted for 32.3% of the answer "sometimes" (Ricijaš, 2016).

The results of a research on the effects of the program for the prevention of aggressive behaviour in elementary schools, show that, after the implementation of the program, the control group achieves more average scores on the scales of direct and indirect aggression of the experimental and placebo group, while the experimental and placebo groups do not mutually differ (Mađar, J.A., 2014). Certain programs that have full support from carriers and implementers of the program, as well as a sufficient level of acceptance by users of the program can have positive effects and should be one of the links in the interdisciplinary approach to the prevention of violence among children and young athletes.

AIM OF THE STUDY

The aim of this study is to provide answers to the following research questions:

1. Do young athletes exhibit verbal violence towards their teammates?
2. Do young athletes exhibit verbal violence towards their opponents?
3. Do young athletes exhibit verbal violence towards judges?
4. Do young athletes exhibit verbal violence towards the audience?

RESEARCH HYPOTHESES

H1 – Percentage of verbal violence in young athletes towards teammates is low. Social cohesion of young athletes stems from the fact that most young people choose sports based on their friends from the school or the neighbourhood. They love to spend time with their friends outside of school as well and together they go to practices and matches. The need for cohesion in this age is very apparent. This is the reason for the assumption that determines this hypothesis.

H2 – Percentage of verbal violence in young athletes towards the opponents is pronounced. Coaches and parents have a significant impact on young athletes.

In order to achieve the results they impose a certain amount of pressure on young athletes. The attempt to impose authority in the course of the competition in order to achieve the expectations is often reflected in some form of verbal violence against the opponent. The young athletes, who aspire to stand out in the group they belong to, use verbal violence as a means to achieve these goals. This is the reason for the assumption that determines this hypothesis.

H3 - Percentage of verbal violence in young athletes towards judges is pronounced. Parents and coaches have a significant impact on young athletes with regard to the formation of behaviour patterns that are reflected in the verbal violence against judges. In addition to the pattern that refers to the attempt to influence the judges' decision about the remainder of the competition, verbal abuse constitutes an act which indirectly justifies poor performance of an individual or a group.

H4 - Percentage of verbal violence in young athletes towards the audience is low. The audience that watches the competition of young athletes mostly consists of parents and friends, therefore the presumption of good relations between young athletes and the audience is quite logical. In addition, the young athletes like the audience's attention as at that age they find attention very flattering.

METHODOLOGY

The study included 432 young athletes of both genders in the territory of Vojvodina, aged 9-17 for the following sports: football, basketball and volleyball. Before completing the questionnaire, all athletes were familiarized with the proper way to do so, as well as with the concept that has been the subject of research and the importance of their anonymous participation. The research included an anonymous survey of young athletes, where the athletes needed to answer with YES or NO to seven dependent variables related to the behaviour of young athletes towards other participants in a sports event. Claims that are related to the behaviour and attitudes of athletes during the competition form the dependent variables:

- Judges can be bribed.
- Sometimes I swear at the judge.
- Sometimes I cannot admit that the opponent is better.
- Sometimes I get into an argument with the opponent.
- Sometimes I get into an argument with my teammate.
- I always congratulate the opponent on his victory.
- Sometimes I get into an argument with someone from the audience.

The survey was conducted from September to November 2016, in 6 sports clubs in the territory of Vojvodina. In order to achieve the objectives of this study the following statistical methods and analysis were used: (1) Methods of descriptive statistics: frequency, percentage distribution (%), (2) methods of comparative statistics: T-test / LSD test / ANOVA / Compare Mean.

RESEARCH RESULTS

Through descriptive statistics, independent variables are presented: age and level of education (elementary school / secondary school), using the frequency (N) and the percentage of the sample (%). Descriptive statistics are included in all of the dependent variables with the same parameters as the independent.

Table 1: Frequency

Age		**N**	**%**
Valid	7-9	61	14,1
	10-12	189	43,8
	13-15	161	37,3
	16-18	21	4,9
	Total	432	100

Table 2: Frequency

Level of education		**N**	**%**
Valid	ES	381	88.2
	SS	51	11.8
	Total	432	100

Descriptive parameters are presented in tables 1 and 2, which more closely describe the sample of respondents. The research included respondents aged 7-18, which were, for easier analysis, divided into ranks. The highest percentage of respondents are 10-12 years of age, while the least represented of the respondents are 15-18 years of age. Table 2 presents the frequencies and percentages of respondents in accordance with the level of education. The results presented in Table 2 indicate a higher presence of primary school age respondents.

In tables 3, 4, 5, 6, 7, 8 and 9, the descriptive parameters of the dependent variables are presented.

Table 3: Frequency

Judges can be bribed		N	%
Valid	YES	211	48.8
	NO	221	51.2
	Total	432	100

The results in Table 3 show the division of the respondents in terms of the view that judges can be bribed. A slightly larger percentage considers that judges aren't corrupt (51.2%).

Table 4: Frequency

Sometimes I swear at the judge		N	%
Valid	YES	152	35.2
	NO	280	64.8
	Total	432	100

A smaller number of respondents confirms verbal abuse, in the form of profanity, towards judges (35.2%).

Table 5: Frequency

Sometimes I cannot admit that the opponent is better		N	%
Valid	YES	253	58.6
	NO	179	41.4
	Total	432	100

In Table 5 we can see interesting results. They suggest that a higher percentage cannot admit the fact that the opponent is better (58.6).

Table 6: Frequency

Sometimes I get into an argument with the opponent		N	%
Valid	YES	215	49.8
	NO	217	50.2
	Total	432	100

Table 6 results indicate a division of respondents in terms of fighting with the opponent, as a specific occurrence in a sports event (49.8% / 50.2%).

Table 7: Frequency

Sometimes I get into an argument with my teammates		N	%
Valid	YES	149	34.5
	NO	283	65.5
	Total	432	100

Unlike arguing with the opponent, the respondents reported that they rarely get into a fight with their teammates, a total of 34.5%.

Table 8: Frequency

I always congratulate the opponent on his victory		N	%
Valid	YES	377	87.3
	NO	55	12.7
	Total	432	100

A significantly higher percentage of respondents (87.3%) reported that they always congratulate the opponent on their victory.

Table 9: Frequency

Sometimes I get into an argument with someone from the audience		N	%
Valid	YES	48	11.1
	NO	384	88.9
	Total	432	100

Data from table 9 indicate that a relatively small percentage of respondents (11.1%) show verbal violence towards people from the audience. By the means of comparative statistics, the results of the following tests have been presented: ANOVA, LSD, Independent Sample Test (T-test) and Compare Mean. More categorical variables (age and sports) were treated using ANOVA with LSD test support, while the variable double categories were subjected to the T-test and Compare MEAN.

Table 10: ANOVA

Age	F	Sig.
Judges can be bribed	6.135	.000
Sometimes I swear at the judge	20.117	.000
Sometimes I get into an argument with opponent	7.938	.000
Sometimes I get into an argument with someone from the audience	8.606	.000

In Table 10, based on the ANOVA variance analysis we can notice statistically significant differences among athletes of different ages in terms of the following dependent variables: "Judges can be bribed," "Sometimes I swear at the judge", "Sometimes I get into an argument with an opponent" and "Sometimes I get into an argument with someone from the audience." In order to conclude among which age categories of athletes there is a statistically significant difference in terms of these variables, it is necessary to apply the LSD test.

Table 11: LSD (age)

Dependent Variable	(I) Age	(J) Age	Mean Difference (I-J)	Sig.
Judges can be bribed	7-9	10-12	.16524	.023
		13-15	.27014*	.000
		16-18	.41920*	.001
Sometimes I swear at the judge	7-9	10-12	.31746*	.000
		13-15	.49689*	.000
		16-18	.57143*	.000
Sometimes I get into an argument with the opponent	7-9	10-12	.15465	.032
		13-15	.30740*	.000
		16-18	.41920*	.001
Sometimes I get into an argument with someone from the audience	10-12	7-9	.11579	.011
		13-15	.13596*	.000
		16-18	.25397*	.000

*The mean difference is significant at the 0.01 level.

The values reported by the means of LSD test, presented in Table 11, indicate statistically significant distinction among athletes ages 7-9 and of older athletes in terms of three dependent variables: "Judges can be bribed," "Sometimes I swear at the judge", "Sometimes I get into an argument with the opponent ". In the same table, we can see that there is no statistically significant difference between athletes aged 10-12 and older athletes (13-15 and 16-18).

Table 12: Compare mean

	Judges can be bribed	Sometimes I swear at the judge	Sometimes I get into an argument with the opponent	Sometimes I get into an argument with someone from the audience
7-9	1.7049	2.0000	1.7040	1.8525
10-12	1.5397	1.6825	1.5503	1.9683
13-15	1.4348	1.5031	1.3975	1.8323
16-18	1.2857	1.4286	1.2857	1.7143
Total	1.5116	1.6481	1.5023	1.8889

Based on a comparison of arithmetic means it can be concluded that athletes aged 7-9 (M = 1.70) do not consider judges to be corrupt in the extent to which older athletes believe them to be (10-12 M = 1.54; 13-15 M = 1.43, M = 1.29 16-18).

Athletes aged 7-9 claim to have never cursed at the judge, for unlike older athletes that actually do curse at the judge (10-12 M = 1.68; 13-15 M = 1.50; 16-18 M = 1.43).

The results of comparing arithmetic means show that athletes aged 7-9 (M = 1.70) more rarely get into arguments with opponents than older athletes (10-12 M = 1.55, M = 1.40 13-15; 16- 18 M = 1.29).

Athletes aged 10-12 significantly less quarrel with someone from the audience compared to athletes aged 13-15 (M = 1.83) and athletes 16-18 years old (M = 1.71).

Independent Samples T-test is used with variables of double categories – age of athletes.

Table 13: T-test (Age)

Independent Sample Test						
T test – (Age)		Levene's Test for Equality of Variances		T -Test for Equality of Means		
		F	Sig.	t	df	Sig.(2-tailed)
Sometimes I cannot admit that the opponent is better.	Equal variances assumed	62.440	.000	2.473	430	.014
	Equal variances not assumed			2.712	68.223	.008

Table 14: Compare mean

Group Statistics			
	Age	N	Mean
Sometimes I cannot admit that the opponent is better	ES	381	1.4357
	SS	51	1.2549

Based on the T-test, it can be concluded that there is a statistically significant difference between athletes of elementary and high school children in terms of the three test variables: "Sometimes I cannot admit that the opponent is better." By comparing the values of arithmetic means (Table 14), it can be concluded that elementary school athletes (M = 1.44), in a lower percentage, cannot come to terms with the fact that the opponent is better, compared to high school athletes (M = 1.25).

DISCUSSION OF RESULTS

A lower percentage of respondents reported accounts of verbal violence towards judges in form of cursing (35.2%). Bad habits in behaviour during the competition, acquired from the model of behaviour of older athletes, sports 'role models' and coaches, represent a significant but not insurmountable obstacle in the way of psycho-social development of young athletes. Athletes who use profanity as a means of taking the spotlight among friends, do it in a bad manner. Different types of frustration and weakness in regard to controlling the score outcomes are compensated by the use of one of the ways of verbal violence directed towards the judges. The results from Table 3 show the division of respondents in terms of the view that judges are corruptible. A slightly larger percentage does not consider judges to be corrupt (51.2%). These results can be viewed with caution due to the fact that young athletes do not have the insight and experiential basis for the formation of such attitudes. Their views on bribery of judges is based on the views of parents, coaches, media and the like. The results are interesting for reasons confirming adequate methodological space for proper pedagogical influence in terms of ways in which the young athletes form their attitudes.

A higher percentage of respondents cannot come to terms with the fact that the opponent is better (58.6%). The results of comparative statistics indicate that there is a statistically significant difference between elementary and high school athletes in terms of accepting the dominance of opponents. High school athletes harder accept the fact that the opponent is better than the athletes of elementary school age. Accepting defeat as an integral part of sports and the value of it as an obstacle to the road of accomplishing objectives, reflects the emotional and psychological maturity of the athletes.

Respondents were divided in terms of the claims relating to arguments with the opponent during the competition, in which 49.8% of respondents answered affirmatively and 50.2% negatively. The attitude towards the opponent represents the acquired form of behaviour, where athletes have formed such behaviour based on cultural patterns to which they have been exposed. The impact of upbringing by parents, coaches and athletes and of the society to whom they belongs represents a significant determinant of the athletes' reactions during the competition. The competition represents a non-specific situation that is filled with a variety of the athletes' emotional expressions, whereby progress of the competition and the outcome significantly influence the behaviour of young athletes.

In contrast to arguments with the opponent, the respondents rarely quarrel with their teammates. Although a significantly smaller percentage of respondents confirmed a fight with a teammate as an integral part of sports competition, this phenomenon is undesirable in sports and significantly reduces the possibility of achieving good results.

Encouraging is the fact that a significantly higher percentage of respondents confirmed that they always congratulate the opponent on his victory. The percentage of respondents who confirmed the claim that they do not always congratulate their opponents indicate the area of pedagogical influence of coaches and psychologists in order to encourage fair play. A relatively small percentage of respondents use verbal violent behaviour towards people from the audience. The relationship of the athletes and the audience represents the field of social interaction, which significantly depends on the psychological preparedness of athletes and socio-psychological structure of the audience. Athletes of younger ages attribute greater importance to the audience, as a factor which confirms and supports the purpose of the competition and performance of the athletes. The fact that someone is interested in a game in which young athletes are participating, justifies the relatively positive attitude that young athletes have towards the audience. Given that the audience that watches the competition of young athletes mostly consists of parents and friends, therefore the presumption of good relations between young athletes and the audience is quite logical.

The results show that athletes of younger ages (7-9) are not inclined to cheat in order to achieve victory, unlike older athletes, especially athletes aged 16-18, who are much more likely to cheat in order to achieve victory.

Summing up the results of the research, it can be concluded that there are certain forms of violent behaviour pertaining to young athletes in competitive conditions, where violence towards opponents is pronounced. The results of this study confirm some of the results mentioned in previous research (Popović, 2011; Ricijaš, 2016) with respect to the present violent behaviour among young athletes.

CONCLUSION

The subject of this research was the attitude of young athletes towards other participants in sport events: teammates, opponents, judges and the audience. The results of this study do not support the hypothesis H1, because 34.5% does not represent a negligible percentage of verbal violence against teammates. The attitude towards teammates is a key factor in establishing a desirable atmosphere in sports clubs with a significant positive impact on performance.

The research results confirm the hypothesis H2, because 49.8% of respondents admitted that they sometimes use rudeness towards the opponent. This percentage is a problem of contemporary sports in terms of wrongly presented priorities and application of unethical behaviour in order to achieve success. The results of this study do not support hypothesis H3, because 35.2% does not constitute a significant representation of the respondents' verbal violence towards judges. Although it did not confirm the hypothesis, the mentioned percentage points to the negative phenomenon that expresses misconduct of young athletes and non-acceptance of judicial decisions.

The results of this study support hypothesis H4, since only 11.1% of respondents engage in verbal conflict with someone from the audience. Young athletes direct their emotions toward the game and the opponent, with a certain respect for the audience attending the match. The assumption is that their respect for the audience stems from the fact that the audience is not directly to blame for dissatisfaction of athletes with the achieved results, as well as the fact that they are easily flattered by the auditorium.

The results of this study confirm the results of previous studies about the presence of verbal abuse among young athletes (Popadić, 2011; Mađar, 2014; Ricijaš, 2016; Milošević, 2016). Given the obvious presence of certain forms of violence with emphasis on verbal violence among young athletes, it is necessary to take certain preventive and corrective actions to remedy the problem.

PREVENTIVE AND CORRECTIVE ACTIONS

The complex character of sports imposes the need for an interdisciplinary approach in order to find appropriate methods of preventing violent behaviour among young people in sports. The fight against the problem in the form of violence among young athletes should be based on the grounds of systematic research in order to define the causes of the aforementioned problems.

In previous research, an attempt has been made to define certain preventive and corrective measures from the point of view of young athletes (Popadić, et al. 2011). This is not only a good example of approaching participants in sporting competitions, but also co-participants of violent behaviour. It is necessary to carry out systematic research of

longitudinal character in order to check the results after implementation of defined prevention and corrective measures. Longitudinal research should include parallel analysis of two sets of measures, one relating to the prevention and the other relating to the correction of the already noted negative behaviours.

THE SIGNIFICANCE OF RESEARCH

The significance of this research is in the analysis and validation of the results from previous research concerning the presence of certain forms of violent behaviour among young athletes with an emphasis on verbal abuse. This study aims to draw attention to the present problem of the society, whose negative effects can leave a trail on sports, as well as outside of it. The results of this research can be useful to coaches of young athletes and physical education teachers so that they can use the pedagogical dimension of their work and direct it towards preventive actions with the upcoming generation of young people. Due to the multidisciplinary structure of sports, the results of this research can be used by researchers from other disciplines. The aim of the research is initiation of future research in this field that is not sufficiently covered by serious scientific analysis. The results allow clarification of the problem that is being insufficiently talked about. The importance is also reflected in the fact that coaches can recognize that there is a real problem in the behaviour of young people, in order to be able to make an influence by defining specific corrective methods in the training process.

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NASILNO PONAŠANJE MLADIH SPORTISTA PREMA OSTALIM UČESNICIMA SPORTSKOG DOGAĐAJA

U ovom radu opisano je istraživanje odnosa mladih sportista prema ostalim učesnicima sportskog događaja. Predmet istraživanja bio je odnos, kao fenomen koji predstavlja socijalnu dimenziju zastupljenu u svakom sportom događaju. Cilj istraživanja bila je analiza odnosa u sportu posmatranih kroz stavove mladih sportista o određenim situacijama u toku takmičenja. Istraživanje je imalo za cilj I da utvrdi kakav odnos imaju mladi sportisti prema saigračima, protivnicima, sudiji i publici.

Ključne riječi: Sportisti, sport, sportski događaj, takmičenje, odnos.

Received: May 15, 2017 / Accepted: May 25, 2017
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NUMBER OF TRIALS AND SESSIONS OF FAMILIARIZATION IN POWER TESTS FOR PHYSICALLY ACTIVE MEN

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ABSTRACT

The aim of this study was to investigate the number of trials and sessions needed to remove learning effects and to stabilize measures in muscle power for upper and lower limbs in physically active individuals. Twenty-five healthy college-men were recruited for this study. Participants performed three sessions with five trials of the following tests: medicine ball throw (MBT), standing long jump (SLJ), squat jump (SJ) and countermovement jump (CMJ). Every testing session began with a 5-min low-intensity general warm-up and tests (MBT, STL, SJ and CMJ) were performed in a randomized order. The participants were instructed to perform five trials of each test with a 30-s rest interval between the trials and 3 minutes between the tests. The results showed the need for one session of familiarization in all lower limbs power assessments (SLJ, SJ, CMJ). We found a ~5% improvement ($p<0.05$) in performance in SLJ, SJ and CMJ from the first to the second and third testing sessions, with no difference between sessions 2 and 3. MBT requires two familiarization sessions to give participants the opportunity to learn the correct execution of the task. SLJ also requires at least two trials of familiarization to stabilize performance scores for every testing session. The results provided in this study allow differentiating the number of necessary sessions and trials of familiarization in field-based muscle power tests in physically active individuals with no previous experience in power assessments.

Keywords: medicine ball throw; standing long jump; vertical jumps; learning effect.

INTRODUCTION

Muscle power is important not only for different sports actions such as sprinting, kicking and jumping (Cormie, McGuigan, Newton, 2011), but also for daily life activities (Drenowatz, Grieve, DeMello, 2015). Different training methods can be used to improve it. However, to ensure that training is effective, it is necessary to correctly evaluate the performance.

Several tests can be used both in the laboratory and in the field to assess muscle power. Generally, laboratory measurements require expensive equipment and precise testing protocols. Even though they are the most valid assessments, they are not feasible to most coaches and practitioners on a daily basis. On the other hand, field measurements are both cost and time efficient and any person can carry them out under "real world" conditions. In spite of lower validity, scores obtained in these tests seems to be reliable and accurate, once learning effects are removed (Atkinson, Nevill, 1998; Hopkins, 2000). Familiarization sessions allow learning the correct execution of the movement, to get stable measures, and to ensure that performance changes are the result of training and not of the learning effect (Turner et al., 2015). For instance, it has been reported that scores in 1 repetition maximum (1-RM) test improve up to 19% after familiarization sessions for a variety of populations (Ribeiro et al., 2014; Do Nascimento et al., 2013; Tiggemann et al., 2011; Ribeiro et al., 2014; Silve-Batista et al., 2011; Soares-Caldeira et al., 2009). Considering that strength gain after resistance training averages 21% (Ahtiainen et al., 2015), the lack of familiarization with the tests may compromise the analysis of the results. However, a few studies investigated the influence of familiarization on field tests of muscle power. Moir et al.(2004) reported that the performance of physical

education students in CMJ and SJ did not improve throughout multiple testing sessions. Markovic et al. (2004) observed that the performance of individuals with previous experience in jumping activities in CMJ, SJ and standing long jump (SLJ) was not affected by performing three trials of each test in the same day. In light of these results, it is conceivable that, in individuals with previous experience in the task and/or good level of physical fitness, there is no need for familiarization in field-based muscle power tests. It is uncertain if the same is true for people who are naive to the tests. Thus, the aim of this study was to investigate the number of trials and sessions needed to remove learning effects and to stabilize measures in muscle power for upper and lower limbs in physically active individuals with no previous experience in these tests.

METHOD

Subjects

Twenty-five healthy college-men (23.6±3.5 years, 71.7±12.1 kg and 1.77±0.06 m) were recruited for this study. All participants were physically active, had no experience in power assessments, and were free of any musculoskeletal and articular injury in upper and lower limbs that could impair the tests execution. All participants signed a written informed consent form after a detailed explanation of the protocol, and the experimental risks and benefits. This study was approved by the University Ethics Committee.

Testing procedures

Participants were required to visit the laboratory on four non-consecutive days. On the first day, they were informed on the experimental procedures and instructed to avoid the use of alcohol, caffeine drinks, and strenuous physical activity 24 hours before the testing sessions. Days 2-4 consisted of testing sessions and were separated by 48–72 h.
Every testing session began with a 5-min low-intensity general warm-up. Tests were performed in a randomized order. The participants were instructed to perform five trials of each test with a 30-s rest interval between the trials and 3 minutes between the tests.

Medicine Ball Throw (MBT): Participants sat on the floor with their back and hips supported by a wall and threw a 3-kg medicine ball from the chest as far as possible. A measuring tape was placed on the floor with the zero point positioned on the wall. The distance of the throw was measured at the place where the ball touched the ground (Harris et al., 2011).
SLJ: Participants were instructed to stand behind a starting line and, with parallel feet, jump forward as far as possible freely determining the arm movements. The zero point of a measuring tape was positioned at the starting line. The distance between the starting point and the closest landing point was recorded.

CMJ and SJ: The vertical jumps were performed on the mat Jump System Fit (CEFISE®, São Paulo, BR) with the obtained flight time being used to estimate the body's centre of gravity rise in height during the jump. In the SJ, a static position with a 90° knee flexion angle was maintained for 2 seconds before every jump attempt. Participants were allowed to perform only the concentric phase. In the CMJ, participants were instructed to execute a downward movement followed by a complete extension of the lower limbs and to carry out the transition between eccentric and concentric phases as quickly as possible. SJ and CMJ were executed with the hands on the hips.

Statistical Analyses

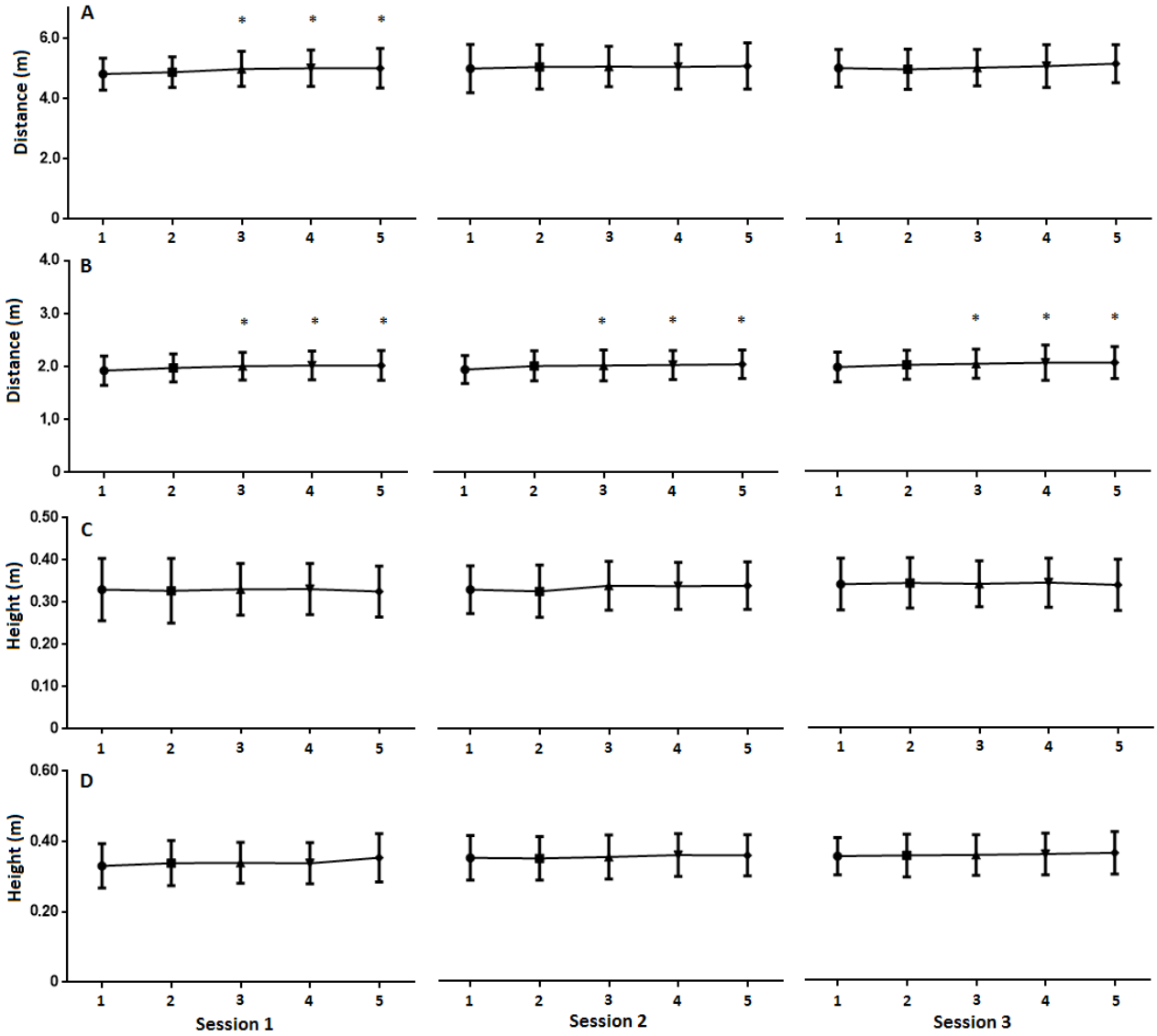
Data were presented in mean (SD) and statistical analyses were processed in the SAS® (SAS University Edition, SAS Institute Inc., Cary, NC, USA). The normality was assessed using the Shapiro Wilk's test. The effect of familiarization on the performance during consecutive trials and consecutive testing sessions was assessed separately with one-way repeated-measures analysis of variance (ANOVA), with the level of significance set at $p<0.05$. When a significant F value was found, Tukey post-hoc test was used to identify the differences.

RESULTS

Performance variations among trials of the same session are presented in Figure 1. Participants improved MBT performance throughout the trials only in the first session. Individuals achieved their best performance in SLJ after the 2nd trial in all of the testing sessions. Performance in SJ and CMJ was not improved throughout the trials.

Mean performances in each testing session are presented in Table 1.
Participants performed best in MBT in the third session, whereas in lower limb tests (CMJ, SJ and SLJ), the best performances were obtained in the second session with no further improvement thereafter.

Figure 1: Performances in A) MBT (m), B) SLJ (m), C) SJ (m), D) CMJ (m), in the five trials of the three testing sessions. p<0.05 compared to the first trial of the corresponding session



DISCUSSION

The main findings of our study indicate: a) the need for one session of familiarization in vertical jump tests (SJ and CMJ); b) at least one session with three trials of familiarization is required for SLJ; c) MBT requires at least two familiarization sessions in physically active individuals.

Moir et al. (2004) and Moir et al. (2005) reported no need for familiarization sessions for SJ and CMJ in physically active men. The authors suggested that the participants were engaged in jumping activities (e.g. volleyball, basketball); consequently they were already familiar with jumping tasks. In our study, individuals had no previous experience in jumping activities and improved SJ and CMJ performances from the first to the second session. It is conceivable that the physical activity experience affects jumping performance over repeated testing sessions. Thus, it is important to familiarize young and healthy individuals, with no previous experience in jumping activities, with at least one testing session in SLJ, SJ and CMJ.

Markovic et al. (2004) analysed the validity and reliability of seven different lower limbs power tests. Based on their results, the authors concluded that CMJ and SJ were the most reliable field tests for physically active men. Our results suggest the need

of one familiarization session for all lower limbs power assessments. Interestingly, an intra-day analysis revealed that SLJ requires at least two trials to stabilize performance scores; even after a familiarization session was performed. SLJ is a more complex task (Markovic et al., 2004) than both SJ and CMJ, thus participants seem to require some "practice" trials to coordinate limbs movements. In the light of these results, it is important to include some maximal trials in the warm-up in every testing session to stabilize performance.

To our knowledge, only one study in upper limbs, investigated the reproducibility of traditional MBT (a throw from the centre of the chest) (Harris et al., 2011). The results showed no need for familiarization in older adults in six trials and two testing days. Our results indicate the need for at least two familiarization sessions in MBT in physically active individuals with no previous experience in this test. It is difficult to compare our results with previous studies due to the different testing protocols and samples characteristics (Harris et al., 2011; Stockbrugger, Haennel, 2001; Duncan, Al-Nakeeb, Nevill, 2005; Clemons, Campbell, Jeansonne, 2010). Possibly, participants require more practice due to the high complexity of the movement, which depends on elbow angle, throwing angle and shoulder position.

CONCLUSION

Researchers, coaches and practitioners should be aware of the number of familiarization sessions required to obtain a stable measure and should not mix training adaptations with learning effects. In lower limbs power tests (SLJ, SJ, CMJ), one familiarization session is required. SLJ also requires at least two trials to achieve the best performance. The MBT can be used to assess the ability of upper-body power as long as there are at least two familiarization sessions.

Table 1: Mean performances in power tests in three different sessions

	Session 1	**Session 2**	**Session 3**	**p-value**
MBT (m)	4.90 (0.5)	4.96 (0.6)	5.02 (0.6)*	0.0291
SLJ (m)	1.93 (0.29)	2.01 (0.27)*	2.03(0.28)*	0.0004
SJ (m)	0.32 (0.05)	0.34 (0.05)*	0.33 (0.05)*	0.0116
CMJ (m)	0.33 (0.06)	0.35 (0.05)*	0.35 (0.05)*	0.0141

Data presented as mean (SD). *different from the first session, p<0.05.

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BROJ POKUŠAJA I SESIJA UPOZNAVANJA TEHNIKE TOKOM TESTOVA SNAGE FIZIČKI AKTIVNIH MUŠKARACA

Cilj ovog istraživanja jeste ispitati broj pokušaja i sesija koji je potreban da se otklone efekti učenja i ustale mjere mišićne snage gornjih i donjih ekstremiteta fizički aktivnih pojedinaca. Dvadeset i pet zdravih studenata je angažirano za ovo istraživanje. Učesnici su izvodili tri sesije sljedećih testova sa pet pokušaja: bacanje medicinske lopte (engl. MBT - medicine ball throw: bacanje medicinske lopte), skok u dalj iz mjesta (engl. SLJ – standing long jump: skok u dalj iz mjesta), skok iz čučnja (engl. SJ – squat jump: skok iz čučnja), i skok sa predpripremom (engl. CMJ – countermovement jump: skok sa predpripremom). Svaka sesija testova je započinjala sa općim zagrijavanjem niskog intenziteta u trajanju od 5 minuta, a testovi (MBT, STL, SJ, i CMJ) su se izvodili nasumično. Učesnicima je data uputa da izvode 5 pokušaja svakog testa sa intervalima odmora od 30 sekundi između pokušaja, i 3 minute između testova. Rezultati su ukazali na potrebu jedne sesije upoznavanja tehnike za sve procjene snage donjih ekstremiteta (SLJ, SJ, CMJ). Otkrili smo ~5% napretka ($p<0,05$) u izvođenju SLJ, SJ i CMJ između prve i druge, te prve i treće sesije testiranja, bez razlike između druge i treće sesije. MBT zahtjeva dvije sesije upoznavanja tehnike kako bi se dala prilika učesnicima da nauče kako pravilno izvršiti zadatak. SLJ također zahtjeva minimalno dva pokušaja tokom kojih se vrši upoznavanje tehnike kako bi se ustalili rezultati izvedbe svake sesije testiranja. Rezultati proizašli iz istraživanja omogućavaju razlikovanje broja potrebnih sesija i pokušaja upoznavanja tehnike testova mišićne snage za određenu grupu mišića kod fizički aktivnih pojedinaca bez prethodnog iskustva u procjeni snage.

Ključne riječi: bacanje medicinske lopte, skok u dalj iz mjesta, vertikalni skokovi; efekat učenja.

Received: June 13, 2017 / Accepted: June 19, 2017
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VARIABILITY OF PRACTICE IN PHYSICAL EXECUTION AND ACTION OBSERVATION: AN EVIDENCE FOR SIMILAR REPRESENTATION

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ABSTRACT

Motor skills could be learned through physical practice or observation. Similar brain areas are activated during physical execution and observation of an action. Also, behavioural findings showed that some rules (such as Fitts's law) hold for both types of performance. These findings support a similar representation between physical execution and action observation, and feedback has been cited as an important reason of this similarity. This hypothesis was tested via comparing motor learning in variable practice conditions with motor learning in constant practice conditions when participants either physically performed a golf putting task or just observed a video model. There were also variable groups (in physical and observational conditions) whose intrinsic feedback about the outcome was withheld. It was reasoned if the feedback is the cause of the similarity between physical execution and observation, the effect of feedback removal should be similar in both conditions. The results revealed that variable groups outperformed the constant practice groups in both physical and observational conditions. In addition, the removal of the intrinsic feedback eliminated the superior performance of variable groups compared with constant groups in both physical and observational conditions. The results supported the notion shared neural network and similar representation between physical execution and action observation.

Keywords: Feedback, Fitt's law, common coding, neurocognitive mechanism, variability of practice.

INTRODUCTION

People usually practice a skill physically in order to learn it. Among skill learning methods, observational learning could be pointed out; a process whereby an observer attempts to repeat the behaviour presented by another person(Williams, Davids, & Williams, 1999). It is believed that there are common neurocognitive mechanisms between physical execution and action observation, and they rely on the same sensorimotor representations (Jeannerod, 2001). As evidence for this claim, it has been revealed that similar brain structures are activated during actual performance and action observation (Grezes & Decety, 2001; Jeannerod, 2001; Rizzolatti & Craighero, 2004).

In addition to these neurophysiological evidence, behavioural evidence, also, support the claim for such a similar representation. For example, in a study, it was examined whether Fitts's law holds during the perception of other people's actions (Grosjean, Shiffrar, & Knoblich, 2007). Researchers asked the participants to watch a sequence of pictures in which a person moved his arm between two identical targets. Target width, the separation between targets, and the movement speed were varied and the subjects had to report whether the person could move at the perceived speed without missing the targets. The results indicated that the movement times reported by participants as being possible were those predicted by Fitts's law. According to the findings, the authors claimed that observation of a particular action relies on the same cognitive processes as performing that action.

Recently, gaze metrics are used to compare behaviour congruence between execution, observation, and imagination of Fitts's task (McCormick, Causer, & Holmes, 2013). The results showed that participants attended the same

task-related visual cues between conditions, and the fixation duration was congruent between action execution and action observation. These findings support the idea of similar sensorimotor representation during observation and actual performance.

At a processing level, simulation and emulation theory claim that there are internal models that act as predictor for action outcomes (Grush, 2004; Jeannerod, 2001). During observation of an action, the same models are used for generating perceptual expectations in the absence of action production (Grush, 2004; Jeannerod, 2001). Researchers believe that the observer can use several forward models for multiple predictions in action observation, and he/she can compare these predictions with the observed behaviour. According to the congruence between predicted and observed behaviour, the observer can infer which controller has to be active to perform the observed action (Wolpert, Doya, & Kawato, 2003; Wolpert & Flanagan, 2001). The point to be noted here is that visual feedback regarding the movement outcome is similar to actual performance during observation. Given that it is shown that feedback during imagery is similar to actual feedback during physical performance, it leads to similar vision dependent learning (Krigolson, Van Gyn, Tremblay, & Heath, 2006; Toussaint, Robin, & Blandin, 2010), and given that it is argued that action observation, imagery and physical execution shared similar representation, this feedback could also be similar for action observation and physical performance, leading to fine tuning of future predictions.

However, in some cases the idea of a similar representation during physical execution and action observation has been questioned. In a study, authors examined whether adaptation to a perturbed visuomotor environment could be obtained via observation (Ong & Hodges, 2010). Two actor groups (with and without vision of the hand) practiced reaching to visual targets with the cursor rotated to the actual hand movement and the observation group viewed their practice. Although, the observation group showed improvement in adaptation to the new visuomotor environment, different from actor groups, they did not show unintentional, negative after effect after returning to normal environment. Accordingly, the authors concluded that the type of learning from observation is different from that encouraged through physical practice (Ong & Hodges, 2010). These findings are replicated in other studies (Hodges, Ong, Larssen, & Lim, 2011; Ong, Larssen, & Hodges, 2012). Also, (Hayes, Andrew, Elliott, Roberts, & Bennett, 2012) concluded the same by using a movement sequence timing task. In their study, the physical group performed the sequence timing task while the observation group watched their performance. After acquisition, the participants performed mirror (same motor commands as those in practice) and non-mirror (same visual spatial coordinates as those in practice) inter-manual transfer tests. Although, the results indicated a positive transfer by both groups in the non-mirror condition, a significant decrement was reported in relative time performance in the mirror condition only after action observation. It was concluded that learning via action observation is underpinned through a visual–spatial representation, while learning via motor-execution highly depends on specific force–time planning (feed forward) and afferent processing associated with sensorimotor feedback (Hayes, Andrew, et al., 2012; Hayes, Elliott, Andrew, Roberts, & Bennett, 2012).

In the current study, it was sought to further test the hypothesis that action observation and actual performance rely on similar representation. We reasoned that if their representations are similar and, manipulating a high level psychological variable, such as variability of practice, should not interact with the form of sensory representation that is used, observed, or experienced. The same argument was used for comparing physical performance and motor imagery (Coelho, Nusbaum, Rosenbaum, & Fenn, 2012). Advantages of variable practice in physical performance have been shown in numerous studies (Van Rossum, 1990; Wulf & Schmidt, 1997). Variable practice should similarly result in a better retention in both physical practice and action observation compared with constant practice if physical execution and action observation share a similar representation.

Moreover, it is argued that if the feedback during observation is similar to feedback during physical performance (as showed for imagery and physical performance (Krigolson et al., 2006)) and it enables performers to correct their errors, the removal of intrinsic KR (Knowledge of Result) should eliminate the advantages of variable practice in observation and physical performance because performers cannot fine-tune their future predictions. These predictions are examined using a golf putting task in which variability of practice is utilized in physical and observational conditions.

According to the simulation theory (Jeannerod, 2001), we predicted that action observation and physical execution share similar representation and applying variable practice during action observation and physical execution would similarly result in better learning than constant practice. Also, we predicted that feedback during action observation and physical practice is similar and feedback removal during variable action observation and physical execution would have a similar effect, eliminating the superiority of variable practice.

METHOD

Participants

A total of 70 male students of Ferdowsi University of Mashhad participated in this study. They were all right handed and naïve to the golf putting task. All of the participants filled in the consent form before participating in the study. They were randomly assigned to physical (30 participants), observational (30 participants), and control (10 participants) groups. The physical practice condition was divided into three sub-groups: physical constant (PC), putting to a fixed target; physical variable+ KR (PV+ KR), putting to variable goals with feedback about the outcome; physical variable+ no KR (PV+ noKR), putting to variable goals without feedback about the outcome. Also, there were three sub-groups in the observational condition, linked to physical groups. The groups were as follows: observational constant (OC), observed the performance of the physical constant group; observational variable+ KR, observed the performance of the physical variable group and saw the outcome of the putting; observational variable+ noKR (OV + noKR), observed the performance of physical variable group, but did not observe the outcome of the putting task. In addition to the experimental groups, a control group (10 participants) was also included.

Procedure

To perform the putting task, a synthetic putting green (9 m long × 4 m wide), a standard right handed putter and standard golf balls were used. Circular targets (4 points) and starting points (5 points) with a diameter of 4 cm were used to create the variability of practice. Two targets (red and green) were used for testing (pre-test and post-test), and the other two targets (blue and white) were used for practice. Placement of the targets and starting points are displayed in Figure 1. The distances and angles of the starting points to each target point are provided in Table 1.

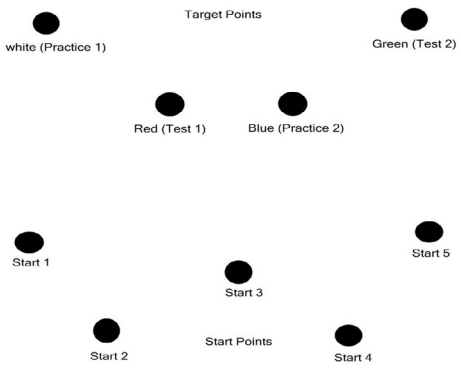

Figure 1: Schematic presentation of start and target

All participants performed a pre-test after they were randomly divided into different groups. They performed 10 trials during the pre-test, through which the participants should hit twice from each starting point to the targets (once for each of the two test targets, red and green). The order of the trials was random with the constraints that no starting point was repeated twice in a row. In this way, during the pre-test, 10 unique trials were performed. Also, the order of the trials was counter-balanced among different groups. Nothing was said to the participants about how to hit, but they were said to try to hit the ball so that it would stop as near as possible to the target.

Table 1: Distances and angles between start points and targets. Angles were measured with respect to a horizontal line drawn through the middle of each start point

Distances and angles for practice targets			
Start point	Target point	Distance (cm)	Angle (deg)
Start 1	Practice 1	291	84
Start 1	Practice 2	251	104
Start 2	Practice 1	327	81
Start 2	Practice 2	280	98
Start 3	Practice 1	311	80
Start 3	Practice 2	256	91
Start 4	Practice 1	318	70
Start 4	Practice 2	247	80
Start 5	Practice 1	343	70
Start 5	Practice 2	281	81
Distances and angles for testing targets			
Start point	Target point	Distance (cm)	Angle (deg)
Start 1	Test 1	235	93
Start 1	Test 2	312	113
Start 2	Test 1	269	88
Start 2	Test 2	338	108
Start 3	Test 1	250	82
Start 3	Test 2	311	100
Start 4	Test 1	252	66
Start 4	Test 2	288	90
Start 5	Test 1	280	79
Start 5	Test 2	330	94

After the pre-test, according to their grouping, the participants practiced the putting task. PC group performed 50 trials (5-block) from the third starting point to the blue target. PV+ KR group completed 50 attempts (5-block) in a random order (i.e., at each attempt, they hit the ball from a different starting point to one of the targets, blue or white, with the constraint of not using a starting point twice in a row). Also, PV+ noKR group performed 50 putts in random order such as the PV+ KR group, but they wore glasses that blocked their vision immediately after hitting the ball and hindered them to see the putting outcome. None of the subjects reported a problem with the glasses. Participants in the physical practice group attempted to putt the ball, so it landed directly on the specified target. Otherwise, participants were not given any instructions on how to putt the ball. Also, the performance of physical groups (PC and PV+ KR groups) was recorded by a video camera (Fuji Hs10) located at the angle of 45 degrees to the starting points to be shown to the observational groups later. The observational groups were paired with the physical groups in a way that the OV+KR observed the performance of PV+KR group and the outcome of putting. The OV+ noKR group observed the performance of PV+ KR group; however, immediately after hitting the ball, the part of the video related to the targets became blurred and the participants did not see the outcome. Also, the OC group observed the performance of the PC group. All the observational groups had no physical attempt during acquisition.

The control group read a text about the benefits of exercise. The time for each participant during the acquisition phase lasted almost an hour, and the control group read the text in this time. The purpose of including a control group was to ensure that any possible improvement in the observational groups could not be explained by performing the pre-test. After 24 hours, the participants performed 10 trials in a random order as a retention test. The order of the trials was counter-balanced between the groups. The performance was measured considering the distance of the ball from the target during the pre-test and post-test.

RESULTS

To analyse the pre-test data, a univariate analysis of variance, 2 (physical modality: physical and observational) × 3 (task variability: variable+ KR, variable+ noKR, and constant), was used. The results showed that the main effect of physical modality ($F<1$) and the main effect of task variability, $F(2.54) = 1.66$, $p = 0.19$, $\eta^2_p = 0.05$ were not significant. Also, the interaction effect of physical modality and task variability was not significant ($F<1$).

Figure 2 depicts the improvement of the groups from pre-test to post-test. To measure learning, the change in performance from pretest to posttest was calculated, taking into account each individual's baseline performance. Also, to quantify learning, the average error during the post-test was subtracted from the average error during the pre-test. A univariate analysis of variance, 2 (physical modality: physical and observational) × 3 (task variability: variable+ KR, variable+ noKR, and constant), was performed on the difference scores. Although, a non-significant main effect of physical modality was observed, $F(1.54) = 1.5$, $p = 0.22$, $\eta^2_p = 0.02$, the main effect of task variability was significant, $F(2.54) = 4.33$, $p = 0.01$, $\eta^2_p = 0.13$. However, the interaction of physical modality and task variability was not significant ($F<1$). Post- hoc comparisons for the main effect of task variability revealed a significant difference between variable+ KR groups and constant groups ($p<0.05$). Also, the difference between variable+ KR groups and variable+ noKR groups was significant ($P<0.05$); however, no significant difference was seen between variable+ noKR groups and constant groups ($P>0.05$). The variable+ KR groups outperformed the other two groups (the means: variable+ KR groups = 35.03, variable+ noKR groups= 15.15, and constant groups = 17.71).

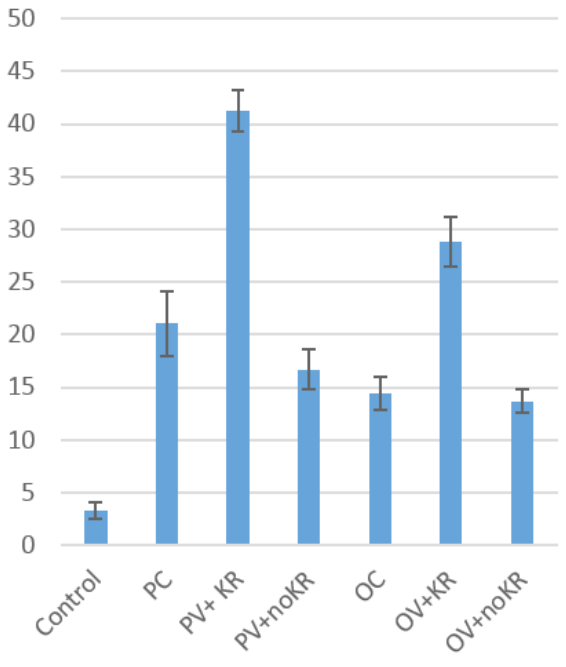

Figure 2: The improvement measured as the difference from pre-test to post-test for each group (PC= Physical Constant, PV+ KR= Physical Variable+ KR, PV+ noKR= Physical Variable+ no KR, OC= Observational Constant, OV+ KR= Observational Variable+ KR, OV+ noKR= Observational Variable+ noKR)

To ensure that the progress of the observational groups was due to the observation of the model and not due to the physical performance during the tests, a one sample T-test was performed on the average improvement for the control group. The results showed that the improvement in this group was not significantly different from zero, t=0.36, df=9, p=0.77.

DISCUSSION

In the present study, it was sought to test the relationship between actual performance and action observation. Previous research suggest a shared similar representation for action observation and physical execution (Jeannerod, 2001). It is possible that, similar to imagery (Krigolson et al., 2006), the available feedback during action observation is similar to physical execution and helps in fine tuning future predictions and also error correction. It is argued that if they shared a similar representation, a psychological variable such as variability of practice should have a similar effect on both types of performance. Also, it was reasoned that if the available feedback during action observation is similar to physical execution and enables people to fine tune their movements, the removal of feedback during variable action observation and physical execution should have a similar impact on these two types of performance and eliminate the usefulness of practice variability. The results supported our hypothesis. The results showed that task variability in both types of performance resulted in better improvement compared with constant practice. Variable practice may allow more generalizability for the allocation of parameters and better error detection mechanisms (Sherwood, 1996; Sherwood & Lee, 2003). In line with previous research (McCormick et al., 2013), these findings support the existence of a similar representation between action observation and physical execution (Decety & Grèzes, 1999; Jeannerod, 2001). It has been shown that Fitts's law holds for physical execution and action observation (Grosjean et al., 2007). It has also been found that during action execution and action observation of the Fitts's task, participants attended the same task-related visual cues between conditions; moreover, fixation duration was congruent between these two types of performance (McCormick et al., 2013).

Also, availability of visual feedback has been stated as a similarity between actual performance and action observation (Grush, 2004), which can help performers to fine tune their future predictions. This probably allows variable groups to outperform other groups during action observation and physical performance, through providing more generalizability in parameter allocation and better error detection mechanisms. This idea is supported by other findings of the present study; it was shown that the removal of feedback during both physical modality (physical performance and action observation) eliminates the superiority of the variable groups to constant groups. Probably, because of the lack of visual feedback, participants could not fine tune their simulation process and increase the accuracy of the future predictions; thus, they could not obtain better generalizability of parameter allocation and error detection mechanisms (characteristics acquired by variable practice). Interestingly, although the participants in variable+ no KR groups (during physical performance and observation) acted poorly than variable+ KR groups, they showed no significant differences in comparison with constant groups, and they showed a higher improvement compared to the control group (see Figure 2). The possible reason for this can be learning of the predictive model. During observation and physical performance, the participants could use the forward model to predict the future state (Wolpert et al., 2003; Wolpert & Flanagan, 2001), but in no KR condition, because of the lack of the feedback, they could not fine tune their future prediction as participants in variable+ KR groups. Such an argument has been employed regarding mental practice; it has been stated that the progress observed in mental practice can be explained by learning the forward model (Gentili, Han, Schweighofer, & Papaxanthis, 2010). The performance of the groups without feedback should be similar to groups that practice mentally, if such an argument is correct (as there is no feedback on the outcome of the action to fine tune the future prediction).Currently, this idea is testing in our laboratory. However, it seems that learning the predictive model is as effective as constant practice in the presence of feedback about the outcome.

In general, the results of this study showed that variability of practice is effective in both physical performance and action observation, supporting a similar representation between these two types of performance. Also, it was shown that the removal of feedback about the outcome (intrinsic KR) during action observation and physical performance leads to the same result and eliminates the benefits of practice variability. These results may also have practical applications. Providing a model that shows the performance of a task in variable conditions can help learners to perform better in retention compared with a constant model.

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VARIJABILNOST PRAKSE U FIZIČKOJ IZVEDBI I POSMATRANJU AKTIVNOSTI: DOKAZ O SLIČNOSTI REPREZENTACIJE

Motoričke vještine se mogu naučiti putem fizičke prakse ili posmatranjem. Slična područja mozga se aktiviraju tokom fizičke izvedbe i posmatranja aktivnosti. Također, otkrića u oblasti ponašanja su ukazala da neka pravila (poput Fittsovog zakona) važe za oba tipa izvedbe. Ova otkrića podržavaju sličnost reprezentacije fizičke izvedbe i posmatranja aktivnosti, a povratne informacije su citirane kao važan razlog ove sličnosti. Ova hipoteza je testirana usporedbom učenja motoričkih vještina u promjenjivim uslovima primjene, sa učenjem motoričkih vještina u nepromjenjivim uslovima primjene gdje su učesnici fizički izvršavali zadatak udaranja golf loptice ili samo posmatrali video model. Postojale su i varijabilne grupe (u fizičkim i uslovima posmatranja) čije svojstvene povratne informacije o ishodu nisu prikazane. Smatralo se da će, ukoliko su povratne informacije uzrok sličnosti između fizičkog izvršenja i posmatranja, efekat uklanjanja povratnih informacija biti sličan u oba uslova. Rezultati su otkrili da su varijabilne grupe nadmašile grupe koje su neprekidno izvršavale zadatak, u fizičkim i uslovima posmatranja. Nadalje, otklanjanje svojstvenih povratnih informacija je uklonilo nadmoćniju izvedbu varijabilnih grupa u odnosu na grupe koje su neprekidno izvršavale zadatak, u fizičkim i uslovima posmatranja. Rezultati su podržali pojam zajedničke neuronske mreže i sličnosti pojave fizičke izvedbe i posmatranja aktivnosti.

Ključne riječi: Povratne informacije, Fittsov zakon, zajedničko kodiranje, neurokognitivni mehanizam, varijabilnost prakse.

Received: December 26, 2016 / Accepted: January 15, 2017
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THE INFLUENCE OF PREDICTOR VARIABLES PERTAINING TO MORPHOLOGICAL CHARACTERISTICS AND MOTOR SKILLS ON THE ATHLETICS ASSESSMENT CRITERIA VARIABLE

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ABSTRACT

The aim of this research is to determine the level of influence morphological characteristics and motor skills have on individual elements of athletics that are envisaged by the curriculum of Physical and Health Education for sixth grades. The survey was conducted on a sample of 103 students from the 6th grade of elementary schools. 9 variables of morphological characteristics, subject to the International Biological Program (IBP), and 12 variables of motor abilities, as predictor variables, have been applied. As a criterion, 3 variables from the subject of athletics were applied. In order to determine the impact of the predictor on the criterion variables, regression analysis was applied. By analysing the results of the entire predictor system (morphological characteristics and motor abilities) regression analysis and the grade in athletics, a statistically significant connection between the predictor and the criterion is noticeable. The partial influence of variations in motor abilities gives variables that reflect the subspace of the explosive power in the lower extremities of the horizontal component, and the explosive forces of the arm and shoulder girdle.

Keywords: morphology, motor skills, athletics, pupils, regression analysis.

INTRODUCTION

Physical and health education, with its contents and values, becomes an integral part of everyday life, regularly proclaimed, a fundamental factor: the health of children and youth, physical development and readiness, fun and entertainment, focusing on a sporting and healthy way of life.

It is certain that physical education and school sports can be an excellent tool in solving numerous problems of education and raising children, raising to a higher level of human capital: health, personal happiness, body and mind abilities, readiness to work, ethics. When assessing the success of teaching, we know which characteristics we should evaluate as the most important, and which come last. We would then easily form the assessment structure that would be a real indicator of success.

Among all the anthropological characteristics, morphological dimensionality is first seen immediately after placing it in front of a student group, and we know that the importance of body structure is a very important predisposition for some sporting activities.

Therefore, the process of understanding the participation of anthropological characteristics in the assessment should start by examining the relations of morphological dimensions with the implementation value of the techniques of the elements that are envisaged by the school curriculum and program, but also by the pedagogue's plan that governs the entire teaching process, which can assess the overall performance of an individual in teaching Physical and Health Education. In teaching Physical and Health Education, it is not possible to measure performance using objective measuring instruments, but qualitatively differentiating the performance of the elements is carried out subjectively - based on the teachers' impressions.

The management of the physical education process is based on a constant inflow of relevant information on the pace and level of the students' general and specific abilities in all the stages of their development. With such an approach it is possible to identify individual needs and appropriate homogenization, create such contents and methods that will accelerate the development of most participants in the teaching process and take appropriate pedagogical measures to improve program content and forms of organization and education.

The aim of the research is to determine the statistical significance of the influence of the system of predictor variables: morphological characteristics and motor abilities on the criterion variable, or on individual criteria from athletics.

METHODS OF RESEARCH

Sample respondents

The sample of respondents was defined from the population, students of the sixth grade, from primary schools "Vukovija" - Vukovija and elementary school "Memici" - Memici. The total number of respondents in this study was 150 students attending the sixth grade of the above schools, where 103 students were subjected to complete testing. Certain students did not complete the tests due to school failure, illness, unwillingness to test, etc.

Sample variables

In this study, 9 variables of morphological characteristics, which are subject to the International Biological Program (IBP), have been applied. The variables are structured from the longitudinal dimensionality of the skeleton, the transferal dimensionality, and the subcutaneous fat tissue. The choice of motor skills variables was based on the criteria of metric characteristics, the limit of which is 0.80 and more, which makes 12 variables. Criterion variables are selected from the technical elements that participate in the final grade in athletics.

Variables for estimating the morphological characteristics of the sample

Longitudinal dimensionality:
- Body height (AVISTI)
- Leg length (ADJUST)
- Length of the arm (ADDRESS)

Transcending dimensionality:
- Shoulder width (AŠIRRA),
- Hip width (AŠIRKU)
- Knee Diameter (ADIJKO).

Subcutaneous fat tissue:
- Abdominal skin crease (ANABTR),
- Back skin crease (ANABLE)
- Lower leg skin crease (ANABPO)

Variables for assessing motor abilities

Explosive power:
- Long jump (MESSKD),
- Throwing a basketball from the chest (MESBKL),
- 20m sprint from a high start (MESSVS).

Flexibility:
- Seated forward bend (MFDUPR),
- Side splits (MFBOŠP),
- Turning the stick over one's head (MFISPA)

Coordination:
- Running in the rectangle - envelope test (MKOKOT),
- Figure eight with bending (MKOSTE),
- Side steps (MKKOST)

Segmental speed:
- Hand tapping (MSBTRU),
- Foot tapping (MSBTNO),
- Tapping the foot against the wall (MSBTNZ).

Criterion variables

Athletics:
- 50 m run (KATTRČ),
- Long jump (KATSKD),
- Long ball throw (KATBAL).

In order to determine the influence of predictor variables of morphological characteristics and motor skills on the criterion variable of athletics, regression analysis was applied.

RESULTS AND DISCUSSION

Regression analysis of morphological characteristics and criterion variables ATLETICS

The entire system of morphological measures shows the general connection of the predictor set with the criterion at a statistically significant level from Sig. = .00 (Table 2) with a high coefficient of multiple correlation of 76% (R = .762) and total explained variation of above 58% (R Square = .580), (Table 40). The obvious contribution of the partial impact of individual variables is typologically oriented and focuses on the variables of the skeleton transversal dimensionality, the diameter of the knee (ADIJKO), the width of the shoulder (AŠIRRA) and the variable of the subcutaneous fat tissue - the skin complex of the lower leg (ANABPO).

From previous scientific findings, it has been confirmed that the measures of transversal and longitudinal dimensionality of the skeleton are in negative correlation, that is, entities with larger dominating transversal measures have, on average, less body height. Assuming that pupils with lower height have mastered the performance of technical athletics elements better, we can almost certainly say that the primary predictive factor of the morphological characteristics of this age is transversal dimensionality closely related to adipose tissue.

Table 1: Variables Entered/Removed

Model	Variables Entered	Variables Removed	Method
1	ANABP, ADUZRU, ASIRRA, ASIRKU, ADIJKO, ANABTR, ADUZNO, ANABLE, AVISTIa	.	Enter

a. All requested variables entered.

Table 2: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.762a	.580	.539	.67871898

a. Predictors: (Constant), ANABP, ADUZRU, ASIRRA, ASIRKU, ADIJKO, ANABTR, ADUZNO, ANABLE, AVISTI

Table 3: ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	59.159	9	6.573	14.269	.000[a]
	Residual	42.841	93	.461		
	Total	102.000	102			

a. Predictors: (Constant), ANABP, ADUZRU, ASIRRA, ASIRKU, ADIJKO, ANABTR, ADUZNO, ANABLE, AVISTI
b. Dependent Variable: ATHLETICS

Table 4: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	-6.333	1.415		-4.476	.000			
	AVISTI	.000	.002	-.074	-.388	.699	.406	-.040	-.026
	ADUZNO	.005	.003	.227	1.400	.165	.505	.144	.094
	ADUZRU	-.003	.004	-.117	-.728	.468	.391	-.075	-.049
	ASIRRA	.013	.004	.313	3.508	.001	.419	.342	.236
	ASIRKU	-.006	.005	-.104	-1.143	.256	.038	-.118	-.077
	ADIJKO	.052	.013	.373	4.020	.000	.549	.385	.270
	ANABTR	-.022	.024	-.136	-.914	.363	-.397	-.094	-.061
	ANABLE	.012	.036	.051	.342	.733	-.355	.035	.023
	ANABP	-.064	.021	-.354	-3.013	.003	-.490	-.298	-.202

a. Dependent Variable: ATHLETICS

Regression analysis of motor skills and criterion variables ATLETICS

The values of the calculated parameters of the motor abilities and the criterion variable ATLETICS regression analysis (Table 8) are prominent in relation to the influence of motor abilities on other investigated elements in this paper. The proof of this is a very high coefficient of multiple correlation amounting to over 81% (R = .813) and a total explained variation of close to 66% (R Square = .662), with the statistical significance of the strictest level of Sig. = .00. (Table 7). None of the variables with individual, partial impacts dominate in relation to others.

In this system of operations, we can confirm the inextricable influence of the entire system of predictor variables (motor abilities) on the criterion variable ATLETICS. In explaining the partial impact of individual predictor variables on the criterion, the primary contribution of the variables reflecting the subspace of the explosive power in the lower extremities of the horizontal component - long jump (MESSKD) and the sprint at 20m from high start (MESSVS), and the explosive strength of the hand and shoulder girdle - basketball throw from the chest (MESBKL).

The secondary contribution is only evident in the variable oscillation (MKOSTE), from the sub-space of coordination. The primary predictive dimension is defined by a factor based on the mechanism for regulating the intensity of muscle fibre excitation and is represented by all the investigated variables of explosive force, which explains almost all of the predictive variance. In relation to the variable that represents the secondary effect, the statement is that we can define this component as a factor of complex partial type structures, because it is represented only by a predictive co-variation variable, with a significantly lower share of the total variance.

Table 5: Variables Entered/Removed

Model	Variables Entered	Variables Removed	Method
1	MSBTNZ, MFISPA, MFDUPR, MKOSTE, MFBOSP, MESSVS, MSBTRU, MSBTNO, MESBKL, MKOKOT, MKKOST, MESSKD[a]	.	Enter

a. All requested variables entered.

Table 6: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.814[a]	.663	.618	.61765865

a. Predictors: (Constant), MSBTNZ, MFISPA, MFDUPR, MKOSTE, MFBOSP, MESSVS, MSBTRU, MSBTNO, MESBKL, MKOKOT, MKKOST, MESSKD

Table 7: ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	67.665	12	5.639	14.780	.000[a]
	Residual	34.335	90	.382		
	Total	102.000	102			

a. Predictors: (Constant), MSBTNZ, MFISPA, MFDUPR, MKOSTE, MFBOSP, MESSVS, MSBTRU, MSBTNO, MESBKL, MKOKOT, MKKOST, MESSKD
b. Dependent Variable: ATHLETICS

All the investigated motor variables have a unique informative component that only works in complete unity, which is probably the cause of the structure of the criterion variable ATLETICS. Each of these variables has a separate cretaceous structure, and separate, complex motor mechanisms are responsible for their realization, so that the manifestation of these athletic tasks, reduced to the first main component, requires a complete totality of the engagement of selected motor skills, resulting in a general impact without the possibility of eliminating any predictor variables.

Table 8: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	1.747	2.005		.871	.386			
	MESSKD	.002	.000	.379	3.564	.001	.714	.352	.218
	MESBKL	.024	.007	.303	3.288	.001	.648	.327	.201
	MESSVS	-.696	.262	-.268	-2.661	.009	-.643	-.270	-.163
	MFDUPR	-.009	.010	-.056	-.822	.413	.061	-.086	-.050
	MFBOSP	.000	.001	-.111	-1.539	.127	.219	-.160	-.094
	MFISPA	.004	.005	.060	.857	.393	.288	.090	.052
	MKOKOT	-.001	.019	-.007	-.077	.939	-.508	-.008	-.005
	MKOSTE	-.116	.041	-.198	-2.832	.006	-.421	-.286	-.173
	MKKOST	.097	.066	.136	1.474	.144	-.400	.153	.090
	MSBTRU	-.027	.020	-.112	-1.369	.174	.210	-.143	-.084
	MSBTNO	.021	.039	.045	.540	.591	.263	.057	.033
	MSBTNZ	.014	.031	.043	.453	.651	.320	.048	.028

a. Dependent Variable: ATHLETICS

CONCLUSION

The aim of this research is to determine the level of influence morphological characteristics and motor skills have on individual elements of athletics that are envisaged by the curriculum of Physical and Health Education for sixth grades.

The entire system of morphological measures shows the general connection of the predictor set with the criterion at a statistically significant level with a high coefficient of multiple correlation of close to 80% and a total explanation of the variability at an above-average, high 58%.

Using the regression analysis at the level of the influence motor skills have on the elements of athletics, the value of the calculated parameters is prominent in the motor skills influence on other investigated elements in this paper.

The proof is that there are very high coefficients of multiple correlation amounting to over 80% and a total explained variation of close to 70%. No variable with individual, partial impact does not dominate in relation to others. By doing so, we can confirm the inextricable influence of the entire system of predictor variables on the criterion variable.

All of these variables have a separate cretaceous structure, and separate, complex motor mechanisms are responsible for their realization, so that the manifestation of these athletic tasks, reduced to the first main component, requires a complete aggregation of the engagements of selected motor skills, resulting in general influence without the possibility of eliminating any predictor variables.

By analysing the results of the entire predictor system (morphological characteristics and motor abilities) regression analysis and the grade in athletics, a statistically significant connection between the predictor and the criterion is noticeable.

The partial influence of variations in motor abilities gives variables that reflect the subspace of the explosive power in the lower extremities of the horizontal component, and the explosive forces of the arm and shoulder girdle.

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UTJECAJ PREDIKTORKIH VARIJABLI MORFOLOŠKIH KARAKTERISTIKA I MOTORIČKIH SPOSOBNOSTI NA KRITERIJSKU VARIJABLU OCJENA IZ ATLETIKE

Cilj ovog istraživanja jeste da se utvrdi razina utjecaja morfoloških karakteristika i motoričkih sposobnosti na pojedinačne elemente iz atletike koji su predviđeni planom i programom Tjelesnog i zdravstvenog odgoja za šeste razrede. Istraživanje je provedeno na uzorku od 103 učenika 6 razreda osnovnih škola. Primjenjeno je 9 varijabli morfoloških karakteristika, a koje podliježu međunarodnom biološkom programu (IBP), i 12 varijabli motoričkih sposobnosti, kao prediktorske varijable. Kao kriterijske, primjenjene su 3 varijable iz predmeta atletika. U cilju utvrđivanja utjecaja prediktorskih na kriterijske varijable primjenjenaje regersijska analiza. Analizirajući rezultate regresijske analize cjelokupnog prediktorskog sustava (morfoloških karakteristika i motoričkih sposobnosti) i ocjene iz predmeta atletika uočljiva je statistički značajna povezanost prediktora s kriterijem. Parcijalni utjecaj varijabli motoričkih sposobnosti daju varijable koje oslikavaju subprostor eksplozivne snage donjih ekstremiteta horizontalne komponente, te eksplozivne snage ruku i ramenog pojasa.

Ključne riječi: morfologija, motorika, atletika, učenici, regresijska analiza.

Received: April 15, 2017 / Accepted: May 1, 2017
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STUDYING THE IMPACT OF REHABILITATION PROGRAM IN ELITE PARALYMPIC ATHLETES

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ABSTRACT

The problem of rehabilitating elite athletes remains one of the latest in rehabilitation and sports medicine. The aim of the research is to increase the effectiveness of recovery after training efforts and prevent sports injuries through a rehabilitation program for elite athletes with disabilities. The experiment was conducted from January to October 2015. The object of the experiment is an elite athlete with disabilities, who is 38-year-old national competitor in athletics in the disciplines of shot put and throwing a disc classified by the IPC's International Classification for athletes with disabilities in group F 57. The tested person is involved in IPC Athletics World Championships Doha (21-31 October 2015). A rehabilitation program was developed and presented for elite athletes with disabilities. A test battery was attached – a visual analogue scale for pain, fatigue and night fatigue; pulse rate; blood pressure; test for confidence, activity, mood; test perceptions of recovery; ultrasound. The analysis of the results showed a positive effect on heart rate, blood pressure, degree of fatigue, night time fatigue and pain, sensations recovery - "loaded", "refreshed", "relaxed" and "recovered". Applying Power Doppler and scanning of medium and small blood vessels account and register enhancing and increasing blood flow after application of massage. The formulated hypothesis that systematic application of the developed rehabilitation program will be beneficial for the sports shape and reduce the risk of injuries in athletes with a disability is confirmed.

Keywords: sports recovery, massage, stretching, manual techniques.

INTRODUCTION

The problem of rehabilitating elite athletes remains one of the latest in rehabilitation and sports medicine. It was found that intensive exercise disturbs homeostasis and causes the body of sportsmen to suffer a whole set of specific violations and non-specific adaptive responses. The issue of preventing fatigue in athletes is particularly topical as they train and find themselves in a state of psycho-emotional stress, and this, of course, increases the risk of injuries and insufficient recovery during the training process (Milanović et all., 2016). Many athletes, thanks to individual endurance and willpower bear physical activity outside of their capabilities. These changes require a long recovery lasting from 2 to 7 days. Studies conducted by some authors (Ferrara and Peterson, 2000, Reynolds et al., 1994, Hemmings et al., 2000) concerning medical problems in healthy athletes and those with disabilities show that there is a similarity with the addition of a certain type of disability, however, some injuries and illnesses are more common than others. In the process, our attention was attracted by medico- biological means of recovery. We started the search, selection and implementation of means of rehabilitation to restore elite athletes with disabilities and evaluate their effectiveness. It was found that manual massage and manual techniques for muscle relaxation and stretching can stimulate recovery processes in athletes with disabilities (Robertson et al., 2004, Zainuddin et al., 2005). This will streamline the process of training and prevention of sports injuries, the cause of which is often fatigue. An optimal recovery, care, good sports participation and representation can be provided through study, research and professional commitment to this unique group of athletes.

MATERIALS AND METHODS

Participants - the object of the experiment was an elite athlete with a disability, who is a 38-year-old national competitor in athletics in the disciplines of shot put and throwing a disc. The respondent is a paralympic champion with a silver medal at the Paralympics in Beijing 2008 and two silver medals winner at the Paralympics in London 2012. The disciplines are classified by the IPC's International Classification for athletes with disabilities in group F 57. The type of damage - amputation of two lower limbs. The participant provided an informed consent before commencing the experiment.

Statistical analysis - SPSS software package has been used for statistical data analysis. Statistical significance was tested at a significance level of $p < 0.05$.

Hypothesis

Scientific facts give us a reason to assume that developing and implementing programs for elite athletes with disabilities will increase the effectiveness of recovery after training loads and prevention of sports injuries, which will be scientifically substantiated by adequate selection methods for functional testing and possibly determine the current state and dynamic changes in the state.

The following basic research tasks for implementing the goal were formulated:
To explore the available information and literature and to analyse the possibilities for recovery of athletes with disabilities after training loads. To study the problem of preventing sports injuries and the factors that influence the organization of sports and recovery process.
To determine appropriate tests and measurements to assess the functional status of elite athletes with a disability, consistent with the purpose of the study.
To develop and experiment a scientifically based rehabilitation program for recovery of athletes with disabilities in sports training load and prevention of sports injuries.

Measures

The subject of the experiment are the changes in the functional indicators in an elite athlete with a disability occurring as a result of the impact of the rehabilitation program. Table 1.

The test "confidence", "activity", "mood" (CAM) methodology was developed in St. Petersburg Military Medical Academy (A. B. Leonova 1984). Perceptions of the recovery test - the extent of four indicators on a linear scale from 0 (absent) to 7 (very strong). Sensations are "refreshed", "loaded", "recovered" and "rested" (B. Hemmings 1998).

The visual analogue scale for pain, fatigue and night fatigue (VAS) - measured by the respondents themselves determines the extent of 0 to 10. Ultrasound - unit GE LOGIQ S7 PRO is used. Through this study, pathological problems are surveyed in the affected joints, muscles, tendons and ligaments; the measured peripheral blood flow of the upper limb with which the athlete throws, after training and after massage in B - mode using Colour and Power Doppler. The changes in echogenicity of the muscle fibres are reported. Muscle fibres change their size whether swelling occurs or not. The blood flow, pulsatile index and the index of arterial resistance were also measured.

Procedures

The experiment was conducted in a rehabilitation centre from January to October 2015. The tested person is involved in IPC Athletics World Championships Doha (21-31 October 2015).
The objective of the research is to increase the effectiveness of recovery after training loads and prevent sports injuries through a rehabilitation program for elite athletes with disabilities. Table 2

Algorithm massage

The massage was applied 120 min after training. It lasted 50-60 minutes, starting from the rear of the lower limbs (5 min each) and continuing with the back (10 min), the nape of the neck (3 min), the lateral portion of the neck and trapezius (3 min), the front portion of the lower limbs (4 min each), the abdomen (5 min), the chest area (5 min) and the upper limbs (8 min).

This order was respected throughout the experiment. The main point was the methodical work inhibitory mode, i.e. it should not cause pain. The selected massage techniques are designed to comply with the muscle groups that are used extensively during the training process. The combination of massage techniques was selected from the available literature describing the massage as a means of recovery from physical exertion. The used techniques were caress, kneading and effleurage. The caress speed of the massage was 20 movements per minute, while kneading and effleurage 50-60 movements per minute. Stroking consisted of rhythmic pressure on the longitudinal axis of each muscle distal to proximal direction. Kneading and effleurage were complemented by squeezing.

Algorithm and technique of post-isometric relaxation and stretching Relaxation of muscles hypertonia was modified in 1981 by K. Levitt's technique of post-isometric relaxation (PIR). (Tab. 3) The stretching exercises that are part of the training program were used with the methodological recommendations of Finando and Finando (2005); Trevell and Simons, (1989); Dyakova and Petkov (2011). The athlete stretches the muscle and hold this position for 10-15 s. For each side, the athlete makes three to five repetitions. Instructions regarding which muscles to stretch and precise instructions about the execution technique of stretching were previously given. Methods: theoretical analysis, content analysis, inductive - deductive logic analysis, experiment, mathematical statistical methods, analysis of time - series, analysis graph, tests.

RESULTS

When it comes to pulse frequency, statistically significant changes have been detected due to the alleviated function of the left heart ventricle, activation of cardiac activity and a decrease in peripheral vascular resistance, which are the result of the appended rehabilitation aids.

The level of significance Asymp. Sig. (.017) from the Runs Test means that the changes reported after massage are consequential. When the difference in the reported averages between the pulse rate before and after the massage is evident from Asymp. Sig. (.001), the results are consequential. (Fig.1)
When measuring blood pressure, the results show that the combination of stretching and massage techniques leads to lower values, which is important for implementing proper adaptation to keep the respondent in a good physical shape and top performance. When the values are measured after massage, Asymp. Sig. - (.023) is an indicator of consequential nature. The difference in mean diastolic pressure, before and after the massage is applied, is reflected in Fig. 2. The level of significance Asymp. Sig. (.000) from the Runs Test emphatically spoke about the statistical significance of these changes.

VAS degree of fatigue, night fatigue and pain

After VAS measurements were taken, the degree of fatigue, night fatigue and pain shows the positive impact of massage and stretching techniques as a means to eliminate fatigue, reduce pain and night fatigue and their effects on the body of the respondent. Fig. 3 tracked the dynamic changes in indicators of the degree of pain, fatigue and night fatigue after including massage.
Lessening of pain after the massage - the result was confirmed emphatically with statistical significance - Asymp. Sig. (.000) from the Runs Test. Changes in pain sensation after exercise and an exclusive massage have a natural character, judging by the level of significance Asymp. Sig. (.000) from the Runs Test. Data from ANOVA for the degree of fatigue and an exclusive massage are statistically significant confirmed by Sig. (.028). Throughout the experimental period, the values of night fatigue after exercise marked a statistically significant change, showing a lessening of the night fatigue - Asymp. Sig. (.000) without a massage and Asymp. Sig. (.011) after the massage.

Establishing the impact of the rehabilitation program on perceptions of recovery

Feeling "Refreshed after a massage" - the value Asimp. Sig. (.000) showed statistically significant changes in mean values. To feel "Loaded after massage" Asimp.Sig. (.019) shows that these are consequential changes. Feeling "Recovered" after massage" - the value Asimp. Sig. (.000) showed statistically significant changes in mean values after massage. Feeling "Rested after massage"- the value Asimp. Sig. (.003) confirmed the statistically significant changes in mean values after the massage. The results of evaluations in sensations recovery - "loaded", "refreshed ", "rested" and "recovered" are statistically significant. The efficiency of the applied resources results in increasing the feelings of rest and recovery. Through appropriate rehabilitation aids side effects of intensive physical exertion are removed. This supports the hypothesis formulated.

Establishing the impact of rehabilitation program on test SAM

From the results of the test SAM, it is shown that the respondent exhibits a high degree of activity and willingness to exercise, as well as reduced concerns about sports injuries and pain and improved confidence in their own abilities. There is absence of tension, discomfort and feeling of tenderness due to the application of properly selected rehabilitation aids. Changes in confidence indicators are statistically significant, as evidenced by data ANOVA Sig. (.050), activity and mood are not supported with statistical significance - Sig. (.255) and Sig. (.070).

Ultrasound

When scanning in B-mode there have been changes in echogenicity of the muscle fibres - after application of a physical effort, there is a slight decrease in echogenicity and appearance of slight swelling of the muscle fibres. After application of stretching and massage it does not indicate a change

in the gray scale (Pic. 1 and 2). Inclusion of the Power Doppler and scanning of medium and small blood vessels account and register a significant difference in the colour Doppler spectrum. After application of the massage an increase of blood flow was registered. The same is expressed in an increase of the brightness in the area of the bright yellow coloured volume at the expense of a dark orange at the periphery, near the walls of the arterial blood vessel. The attached sonograms confirmed the above conclusions. In the study, measurements in a pulsed Doppler mode of arterial blood vessels by their lumen diameter between 1.8 and 4 mm were carried out. Differences in speed of blood flow and changes in pulsatile index and index of resistance after massage were recorded and reported. (Pic. 3)

Discussion

Massage and soft tissue relaxation techniques are an important component of the training process for many elite athletes. According to Zainuddin et al. (2005), utility is manifested by a rapid recovery after a hard workout or a race. They have an important role in the prevention of injury, particularly in terms of the negative effect of overload and fatigue. Robertson et al., (2004) prove the positive role of massage in the process of rehabilitation after injury. Publications Hemmings et al., (2000); Robertson et al., (2004) indicate that some of the claims on physiological effects of massage are not supported by evidence, such as changes in blood flow in certain tissues results in elimination of toxins.

Camborn, et al., (2006) examined the effects of massage on blood pressure. The authors recommend sports massage as a more active type of massage to achieve top performance and using a combination of techniques including joint mobilization, stretching and / or relaxation post-isometric, transverse friction massage and acupressure. The authors found that individuals being targeted with a Swedish massage (effleurage and petrissage) receive the greatest drop in blood pressure, while those who have received a trigger point therapy and sports massage are found to increase blood pressure.

Dawson and Tiidus (2004); Hilbert et al., (2003) reported that massage can have a positive impact on the perception of the intensity of pain, but not until 48 hours after workout.

Theoretical considerations of Carr (2006); M. Aourell et al., (2005) are that massage helps the athlete to cope with anxiety and stress before the game and thus reduces the risk of sustaining an injury and performance level below expectations.
More recent studies - Hovind and Nielsen (1974); Shoemaker, et al., (1997); Hinds et al. (2004) using Doppler ultrasound techniques have found that massage had no effect on arterial or venous blood flow.

CONCLUSION

In the available literature, post examining the impact of a rehabilitation program with massage, stretching and post-isometric relaxation as a certain algorithm to influence the sports form, prevent injuries and create prerequisites for improving competitive performance for athletes with a disability has not been found. The rehabilitation program developed for recovery and prevention of sports injuries has been experimentally justified. The systematic implementation of the rehabilitation program favourably affected the sports form, reduced the risk of injuries and created prerequisites for improving competitive performance in athletes with a disability. The stated hypothesis has been confirmed. The applied significance of the developed rehabilitation program has been proven.

Table 1: Measurements

Measurements before massage	Measurements after massage	Measurements after training with weights	Measurements units
Visual analogue scale for pain (VAS)	Visual analogue scale for pain (VAS)	Visual analogue scale for pain (VAS)	**0 – 10** **n**
Visual analogue scale for fatigue (VAS)	Visual analogue scale for fatigue (VAS)	Visual analogue scale for fatigue (VAS)	**0 – 10** **n**
	Visual analogue scale for night fatigue (VAS)	Visual analogue scale for night fatigue (VAS)	**0 – 10** **n**
	Test Perceptions of recovery "refreshed" "rested" "recovered" "loaded"		**0-7** **n**
	Blood pressure		**Mm Hg**
	Pulse rate		**Numb palp/min**
	Test "confidence" "activity" "mood" (CAM)		**(+3) – (-3)** **n**
Ultrasound	Ultrasound	Ultrasound	**cm/s**

Table 2: Rehabilitation program during the experimental period

№	Rehabilitation program through the training cycle	Dosage
	Preparatory period (nine months)	
1.	Restorative massage	2 times a week, 120 min after the workout
2.	Post-isometric Muscle Relaxation	2 times a week after massage
3.	Stretching exercises for specific muscle	As an additional part of training
	Pre-competition experimental period - 20 days before the competition (October)	
1.	Restorative massage	5 times a week, 120 min after the workout
2.	Post-isometric Muscle Relaxation	5 times a week after massage
3.	Stretching exercises for specific muscle	As an additional part of training

Table 3: Target (affected) muscles that are treated with PIR

Number	Muscle	During the application	Intensity of application	Dosage
19	M. Latissimus dorsi; M. Pectoralis major- pars abdominalis; M. Teres major; M. Deltoideus – pars spinata; M. Infraspinatus; M. Serratus anterior; M. Trapezius pars descendens; M. Levator scapulae; M. Biceps brachii (caput breve); M. Brachioradialis; M. Brachialis; M. Triceps brachii (caput laterale et caput mediale) etm. anconeus; M. Pronator teres et Pronator quadrates; M. Supinator; M. Flexor carpi radialis; Mm. Extensors of the lumbar spine; M. Extensor carpi radialis; Mm. engines thoracic spine; Mm. engines of lower thoracic and lumbar spine	After massage	Each muscle that is found in shortening or hypertonia is treated twice a week	Three to five repetitions for each muscle to be treated

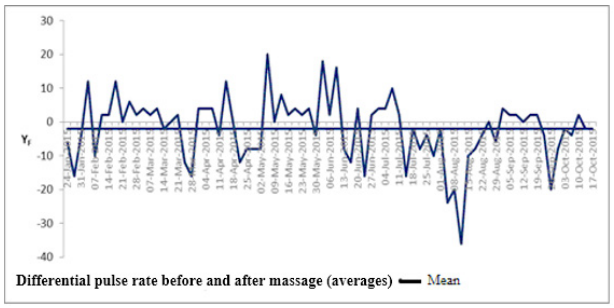


Figure 1: Differential pulse rate before and after massage (averages)

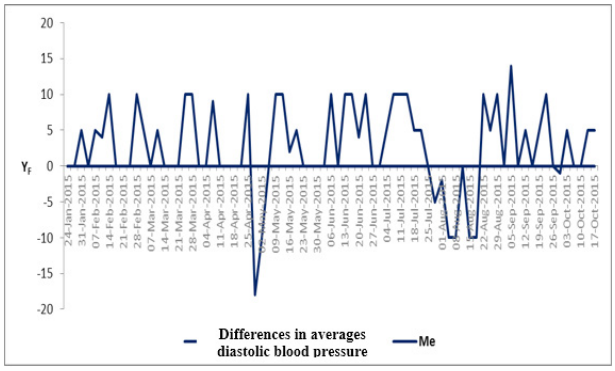


Figure 2: Differences in averages diastolic blood pressure

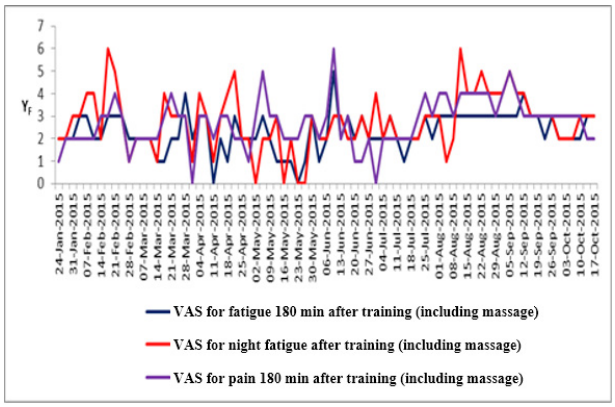
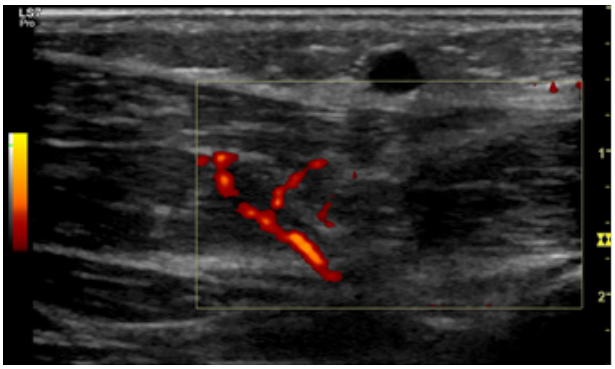
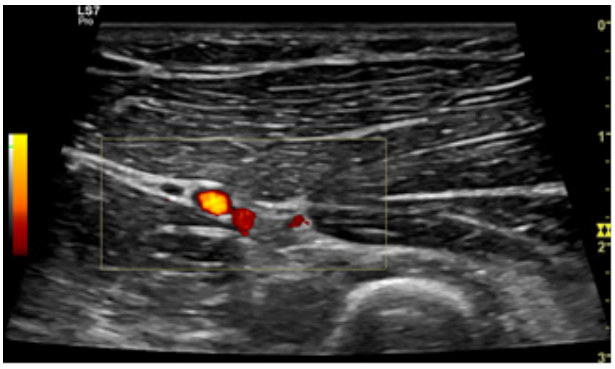


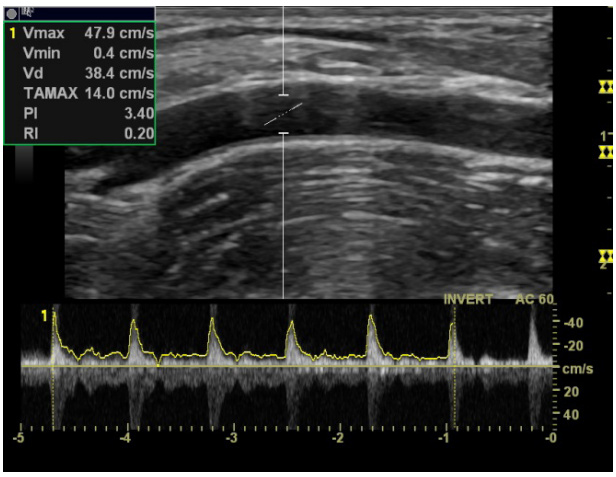
Figure 3: VAS for fatigue 180 min after training (including massage)
VAS for night fatigue after training (including massage)
VAS for pain 180 min after training (including massage)



Picture 1: Power Doppler: shoulder after massage



Picture 2: Ultrasound: forearm after massage



Picture 3: Artery with a diameter of 3,5 mm after application of massage

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ISTRAŽIVANJE UČINKA PROGRAMA REHABILITACIJE ELITNIH PARAOLIMPIJSKIH SPORTISTA

Problem rehabilitacije elitnih sportista ostaje jedan od najnovijih problema koji se javljaju u rehabilitaciji i sportskoj medicini. Cilj ovog istraživanja je povećati efektivnost oporavka nakon pokušaja treniranja, te spriječiti sportske povrede putem programa rehabilitacije za elitne sportiste sa invaliditetom. Eksperiment je proveden u periodu od januara do oktobra 2015. godine. Predmet eksperimenta je tridesetosmogodišnji elitni sportista sa invaliditetom koji je atletski reprezentativac u disciplinama bacanja kugle i diska klasificiranim putem međunarodne klasifikacije za sportiste sa invaliditetom u grupi F 57 Međunarodnog paraolimpijskog komiteta IPC (engl. IPC - International ParalympicCommittee: Međunarodni paraolimpijski komitet). Testirana osoba je učestvovala na IPC svjetskom prvenstvu u atletici u Dohi (21-31 oktobar 2015. godine). Rehabilitacijski program je osmišljen i predstavljen za elitne sportiste sa invaliditetom. Priložena je i baterija testova - vizualno-analogna skala boli, umora i noćne iscrpljenosti; otkucaji srca; krvni pritisak; test samopouzdanja, aktivnosti, raspoloženja; test zapažanja oporavka; ultrazvuk. Analiza rezultata je pokazala pozitivan efekat na otkucaje srca, krvni pritisak, stepen umora, iscrpljenost i bol tokom noći, povrat osjetila - "ispunjen", "okrijepljen", "opušten" i "oporavljen". Primjena Power (osnaženog) Dopplera i snimanje srednje velikih i malih krvnih žila prikazuju i bilježe poboljšanje i povećanje protoka krvi nakon masaže. Potvrđena je formulisana hipoteza da će sistematska primjena razvijenog programa rehabilitacije biti korisna za sportsku formu i smanjiti rizik od povreda kod sportista sa invaliditetom.

Ključne riječi: Oporavak sportista, masaža, istezanje, tehnike ručne terapije.

Received: January 22, 2017 / Accepted: March 18, 2017
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A NORMATIVE AND FUNCTIONAL REVIEW OF THE INSTITUTIONAL POSITION OF ATHLETES

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ABSTRACT

This paper deals with a normative and functional representation of athletes within the Montenegrin Olympic movement. The intention is to open a debate with a view of disclosing a set of measures or mechanisms to eliminate institutional obstacles for athletes, i.e. to provide an adequate institutional representation and protection of their rights. The relationship between the Montenegrin Olympic Committee, and NSFs, bearing in mind the fundamental documents of the International Olympic Committee and its activities in the field of interest is particularly important for the presented challenge.

Keywords: Normative, athlete, functionality.

INTRODUCTION

In order to adjust the Olympic Movement in Montenegro, it is necessary to welcome de Coubertin's idea of an athlete as a centre and an athlete as a vehicle for sharing/promoting Olympic principles: "In order for 100 people to develop their bodies it is necessary for 50 to practice a sport, and in order for 50 to practice a sport it is necessary for 20 to specialize; but in order for 20 to specialize it is necessary for 5 to be capable of outstanding achievement."

Going from the statistical position that Montenegro is a country with a population of under one million people, sport activities should be controlled by state authorities, but with decentralizing principles within National Sport Federations (constituents of Montenegrin NOC). Under State control, Italian Olympic Committee (CONI) is in charge of sport activities. Decentralizing principles means that all who actively participate in a specific sport (from athletes to the sponsors) should be involved. The United States Tennis Association (USTA) is an example where athletes, coaches, referees and sponsors actively participate within USTA various Committees, provided by USTA Constitution, Bylaws, and diversity and inclusion statement.

Sport plays a very important role in the Montenegrin overall identity, especially in times where economic crises tremendously increased the gap between classes, with negative effects on socialization of the vulnerable population. With these negative outcomes, sports organizations tended to follow the organizational structure of other governmental organizations. In his work, Chifflet defines three different types of organizational cultures of the sport governing bodies: the association culture of the elected volunteer executives, which is based on the federal values of amateurism and volunteering; the public service culture of public servants, who are placed at different levels within the federation formally, (Montenegrin sports organizations tend to follow this organizational group); and the managerial culture of managers and experts, which is based on meritocracy, performance and profitability.
On the other hand, not many studies have addressed issues related to sports organizations from a relational perspective.

MOC-NSF RELATIONSHIP STRUCTURE

The legal position of the Montenegrin Olympic Committee is a federation of all sports federations (non-Olympic sports as well). Strategy and action plans depend on NOC of Montenegro General

Assembly comprised by various representatives of Sports Movement (national sports federation representatives). Crozier and Friedberg, having in mind the organizational system that is increasingly bureaucratic, suggested that stakeholders operate with a significant level of autonomy. Although they are obliged to adhere to the statutory obligations, representatives are still inclined to make decisions based on their informal alliances in order to meet their private interests. Despite obstacles within society, Coakley concluded that sports is consisted of rules created by interpersonal cooperation. Contextual cultural elements (taken for granted) are widely spread within the Montenegrin Olympic Movement decision-making process. The National Sports Federations are governmental organizations consisting of a union of sports clubs as their members. The majority of clubs are either in private ownership or are public ones fully controlled by private individuals (usually connected with political stakeholders).

The review of Statutes (umbrella legal tool of every NSF) leads to a conclusion that the priority or a central point of NFS in Montenegro is the athletes' development. Athlete development implies enabling the best possible conditions to participate in order to develop them and achieve the best possible sporting results. Basically, the rest of the Statute does not provide any legal or additional bylaw which could provide practical application of the above mentioned. Clearly, informal alliances are built in line with the needs expressed in the stakeholders' common share goals in order to remain in position and to maximize their interest. For example, the situation in Czech governing bodies is analysed by Numerato:

'From the perspective of social capital, a sport governing body represents an institution as a set of network ties which have a certain configuration and which are organized in a certain way. The members of a federation share cognitive images about themselves and the relationships are maintained through a certain level of trust. Behavior of the association members, who are more or less identified with a sport movement, is regulated by norms and obligations'.

WHERE THE ATHLETES ARE?

The current constitution of NSF affected by global economic crises on the one hand and accepting market oriented philosophy without necessary legal instruments (Statues and Bylaws for improvement of the athletes' position) on the other hand create overall neglect of athletes with the only aim for stakeholders to receive state funds and to expand the sphere of their influence. Most NSFs, via Statutes, didn't predict the institutional position of athletes. A positive example is the Football Association of Montenegro, where clubs, athletes, coaches, referees, medical stuff and grassroots representatives have their own unions within the umbrella federation. The central issue of the Olympic movement in Montenegro is the vulnerable position of athletes (legally and practically). In his speech, Frank Frederiks noted that
"there is no doubt that without athletes, there will be no Olympic Games, there will be no sport".

Without institutional support during the sporting career, the career after sport is uncertain and blurry and there had been many evidence about athletes using alcohol to deal with the end of their sporting career. Let's pay attention to the IOC Congress recommendations from October 2009:

"All athletes are at the heart of the Olympic Movement. They are supported by extensive structures which include, in particular, local clubs, National and International Federations and National Olympic Committees... Athletes should be encouraged to play an integral part in the organization and development throughout the twenty first century."

On the other hand, regarding the uncertain path of athletes, Fuchs Ebaugh (1988) noted:

"The process of disengagement from a role that is central to one's self-identity and the reestablishment of an identity in a new role that takes into account one's ex-role constitutes the process I call role exit."

The Olympic Movement in Montenegro doesn't recognize either formal or informal structured institutions to protect the athletes in order to remain productive after their sporting career. This is very important because they could serve as role models on the one side, and more importantly, it could significantly reduce the possibility for an ex-athlete to become a social problem on the other side. As a continuation regarding the development of athletes:

"Athletes from across the globe and from all sports should have access to an appropriate level of basic legal advice and guidance throughout their sporting careers. Stakeholders of the Olympic Movement should, at their cost, identify policies and procedures to achieve this objective."

The Olympic Movement in Montenegro is a state oriented system with private or politically eligible

individuals in charge and with constellation at the NOC of Montenegro makes them very influential. The Statute of Montenegrin NOC enables NFS representatives to take positions in various commissions regardless of whether they possess the necessary prerequisite for it. Athletes should be included in the overall decision-making processes. The role of athletes in the Olympic Movement institutions:

"Athletes must be included within the decision-making bodies of the Olympic Movement through Athletes' Commissions and other positions that carry full voting rights."

This doesn't mean, of course, that it will solve all the problems. Availability to take part in, may not fully resolve the issues in the relational triangle (community-athletes-Olympic Movement organizations) as McFee argued "One cannot, for instance, resolve all difficulties in a particular sport by making new rules for that sport, rules which deal with every situation unequivocally". Informal ties usually become the praxis that in many cases become a "wall" formal interests of the NSF. One of the most obvious reasons serving as a braking mechanism could be explained by Cashmore:

"Crisis of legitimacy of contemporary dispute resolution mechanisms, which are contested due to the commercialization and professionalization of sport."

Fully aware that this is not an ordinary constellation within NSF, it is important to note that the formational historical background of NSF (the socialist period/public ownership up to the mid-80s and the introduction of capitalism principles with the lack of legal institutional protection from the 90s) force on the only possible constellation in order to put athletes in a position to be heard and to take part of the responsibility in the managing of NSF. The beginning of the transformation should start by adapting the existing Statutes and since the majority of National Sport Federation are dominantly (over 90%) financed by state funds, to welcome public representatives on the managing positions. Having in mind that NSF are state oriented organizations, it is important to encourage formation of individual associations of athletes, coaches, referees, parents and the pool of sponsors within NSF and to take an equal role in the decision-making process. Above all, the constellation of relations within NSF with importance of autonomy in sports could serve as protection from any kind of mistreatment in specific sport, allowing all participants to be equally represented. In the section of the IOC recommendations from the 2009 Congress, "The Structure of the Olympic Movement", the autonomy of sport is noted as an essential segment in order to promote diversity and individuality:

"The relevant intergovernmental organizations and governments should acknowledge the necessary and essential autonomy of the Olympic Movement including, in particular, respect for and enforcement of the rules of good governance, equality and fairness in sport and sport administration, as established by the Olympic Movement and set out in the Olympic Charter, to ensure the best and fairest possible practice of sport... All constituents of the Olympic Movement should review their rules and activities to ensure that they fully comply with the Olympic Charter and the fundamental principles and values of Olympism."

The perception of autonomy within the Montenegrin Olympic Movement (mainly at NSF structures) is mostly missed, used as term for being sovereign, especially when it comes to making strategic decisions for the development of a sport system or within a specific sport on one the hand and the way of spending state funds (allocated for athletes development) on the other hand.

CONCLUDING REMARKS

Concluding remarks
The institutional position of athletes was deliberately taken into consideration with the aim of disclosing the organizational structure of the Montenegrin Olympic Movement with an emphasis on National Sport Federations as an essential segment (organizational). There are two main reasons why this approach has been chosen. First, there were not many studies on the relational aspects within sporting organizations regarding the athletes' position. The second one is that in a country of transition, the legal basis should be considered as a vital foundation for the construction of relations. Relational forms, included via construction of institutions in order to protect the athletes' position on the one hand and to enhance the opportunities for developing an overall state potential through the Montenegrin Olympic Movement on the other. The aim of this paper is not to oppose to the existing structure, but to note the vulnerable position of athletes and to serve as guidance (athletes taking responsibility in their own hands) for improving the organizational structure of the Montenegrin Olympic Movement.

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NORMATIVNI I FUNKCIONALNI PREGLED INSTITUCIONALNOG POLOŽAJA SPORTISTA

Ovaj rad tretira normativno i funkcionalnu zastupljenost sportista u okviru Crnogorskog olimpijskog pokreta.Namjera je da se otvori debata sa ciljem osmišljavanja mehanizama koji će eliminisati institucionalne prepreke za sportiste, tj. obezbijediti adekvatnu institucionalnu zastupljenost i zaštitu svojih prava. Za naprijed iznijeti izazov, posebno važna je relacija između Crnogorskog olimpijskog komiteta i krovnih sportskih organizacija (saveza), imajući u vidu temeljna dokumenta Međunarodnog olimpijskog komiteta i aktivnosti koji isti preduzima u predmetnoj oblasti..

Ključne riječi: Normativi, sportisti, funkcionalnost.

Received: June 1, 2017 / Accepted: June 15, 2017
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THE EFFECT OF CORRECTIVE EXERCISE WITH VIBRATION ON FORWARD HEAD AND ROUND SHOULDER POSTURE

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ABSTRACT

The purpose of this study was to investigate the effect of corrective exercise with vibration on forward head and round shoulder posture. The research method was semi-experimental and the population was non-athlete male students (18-27 years). 15 individuals were randomly selected for corrective exercise with vibration, and 15 individuals were selected for the control group. Forward head and round shoulder posture were measured by side photography. The protocol was 10 weeks, 3 times per week and 30-60 minutes per session. The collected data were analysed by a paired sample T-test and Independent T-test using SPSS-21. The paired sample T-test results showed that there were significant differences in forward head (P=0.00) and round shoulder (P=0.00) posture before and after the 10 weeks long corrective exercise with vibration. Also, there was a significant difference in the posttest of the experimental and control groups (P< 0.05). Vibration training is based on activating muscle spindles. Muscle spindles produce feedback by stretching the muscle γ afferent neuron. It can be concluded that corrective exercises using vibration had a positive impact on the correction of forward head and round shoulder posture, so it can be recommended as a treatment modality for individuals suffering from this problem.

Keywords: forward head posture, round shoulder posture, whole body vibration, corrective exercise.

INTRODUCTION

Weakness or shortness of muscle can lead to a bad posture which results in routine weakness and shortness of muscles. This can be accompanied by everyday habits like sitting inappropriately and can cause abnormalities in the body (Peterson-Kendall et al., 2005). Moreover, the upper quarter of the trunk, which is one of the most important and complex body parts, may develop various abnormalities due to shortness and weakness of muscles. Two common abnormalities in this area are forward head and round shoulder posture. In these anomalies, the head and shoulders move forward (Page et al., 2010). In this deformity, pectoralis major and minor, shoulder internal rotators, as well as sub occipital muscle become shortened and facilitated and trapezius and rhomboid muscles, as well as shoulder external rotators became weak and inhibited (Clarkand Lucett 2010, Page and et al., 2010). Forward head and shoulders posture are treated and reformed through different methods, which include manual treatment (Bergman et al., 2004), postural retraining (Birbaumer et al., 1994) using bandages (Greigand et al., 2008) and exercise therapy (Patterson-Kendall et al., 2005, Seidi et al., 2014). In exercise therapy or corrective exercises, the focus is on stretching the shortened muscles in the chest and strengthening the muscles of the posterior part of the body through physical exercise (Patterson-Kendall et al., 2005). Routine corrective exercises with an emphasis on stretching and strengthening exercises are performed with body movements. One of the new tools is the Whole Body Vibration device (WBV). Whole Body Vibration was introduced as a new method to develop muscle performance and improve bio-motor factors and was

widely used in professional sports, fitness centres and rehabilitation clinics (Kurt and Pekünlü2015). This device also causes tonic vibration reflex. This contractual reflex is caused by the stimulation of the muscle spindles which leads to an increase in activity of sensory neurons (Albasini et al., 2008). Vibration also causes an increase in body temperature and this elevated body temperature in turn increases the release of oxygen from myoglobin and haemoglobin, increases blood flow to muscles, increases sensitivity of nerve receptors and the speed of nerve impulses, as well as reduces viscosity and decreases muscle tone (Cardinale and Bosco, 2003). According to researchers, in individuals with forward head and forward shoulders posture, the external rotation of the arm is reduced due to a pectoralis major shortness and there is also weakness of the scapula retractors (Peterson Kendall et al., 2005). Over the past decade, the whole body vibration machine was received positively and its use continues to expand. Moreover, it has attracted the attention of scientists all around the world in different fields of sports studies and treatment with different objectives, regarding the effectiveness of training with whole body vibration, as well as the lack of a research which tested the corrective exercises with this device. The aim of this study was to evaluate the effect of corrective exercises with a whole body vibration device on forward head and shoulder posture.

METHODS

Sample subjects

The present research is a quasi-experimental study. The study population included all non-athlete, 18 to 27 years old, male students, who have forward head and shoulder posture deformity. The sample calculation was based on formula and one of the previous studies. The participants consisted of 30 university students who volunteered to enter the study, and then based on random categorization, they were divided into two groups, one group with 15 students for corrective exercise with vibration and another group for control. Inclusion criteria for the study sample is having both forward head posture greater than 45 degrees and shoulder posture greater than 52 degrees (Harman et al., 2005, Thigpen et al., 2010, Seidi, 2014).

Tests and measurements

The angles of head and shoulders forward posture in the study were measured by using side photography (Figure 1) (Harman et al., 2005, Seidi, 2014). To measure the angles of the head and shoulders forward posture using this method, at first, three landmark tragus of the ear, prominent acromion and the spinous process of the seventh cervical vertebrae were found. Subjects then stand in silhouette form and a photo is shot by a digital camera at a distance of 265 cm from their lateral side (Harman et al., 2005, Seidi, 2014). Then, by using AutoCAD software, the angle line linking tragus and the seventh cervical vertebrae with the vertical line (forward head angle) and the acromion process with the vertical line (forward shoulder angle) were measured (Seidi2014). This method (Figure 1) has a good reliability and has been used in several studies (Harman et al., 2005, Thigpen et al., 2010, Ruivo et al., 2016).

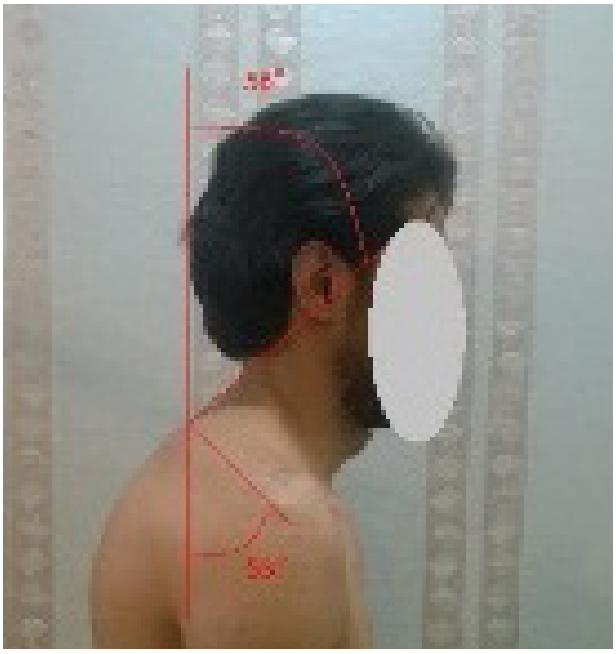

Figure 1: Shows how to measure the forward head and shoulder posture using side photography

Training program

The training protocol was conducted three times a week for 10 weeks (Seidi2014). Each session lasted approximately 30-60 minutes. This time was considered for warm-ups and major exercises. (Seidi2014). Training exercises were designed in a way that influenced both the deformity (forward head and shoulder posture) and the individual participating in training, in a dynamic and active form. (Shown in Figure 2). In addition, at the beginning of the session, flexibility exercises were performed at the frequency of 18 Hz and an amplitude of 4-2 mm. In contrast, strength training has a frequency of 50 Hz and the individual exercised with the device for a maximum of two minutes. This exercise was done in 3 sets (maximum) with 60 to 90 seconds rest (Albasini et al., 2008).

Methods of data processing

A single blind method was used to record data. In all the measuring stages, all the data was recorded by one of the research colleagues and the researcher was not aware of the quantity of data and the difference in pre-test and post-test. In order to analyse the data, independent and dependent T-tests were used. Throughout the study, the significance level was 95% with a consideration of a smaller alpha or that equal to 0/05. All statistical analyses were performed using SPSS-21 software.

Figure 2: Whole Body Vibration exercise machine

RESULTS

Some of the anthropometric characteristics of participants are shown in table 1.

Table 1: Anthropometric characteristic of participants (N=30)

	group	n	mean	s. d	Independent t	P
Age	Vibration	15	23.5	2.3	1.37	0.26
	Control	15	24.4	2.1		
Height	Vibration	15	172	5.9	1.0	0.32
	Control	15	169	5.7		
Weight	Vibration	15	68.4	5.7	0.8	0.37
	Control	15	66.7	4.7		
BMI	Vibration	15	23.5	1.5	0.1	0.92
	Control	15	23.5	2.1		

Table 1 shows that there is no significant difference in anthropometric characteristics in the two groups in pretest, so the groups are paired. To investigate the difference between and within group effects, independent T and paired sample T-test were used. These results are shown in table 2.

Table 2: T-test results

	group	mean± s. d		Paired t	P	Independent t	P
		Pretest	Posttest				
Forward head	Vibration	54.1±3.8	39.1±3.5	33.5	0.00	25.7	0.00
	Control	51.5±4.5	51.2±4.7	0.9	0.36		
Round shoulder	Vibration	57.1±3.8	44.8±3.7	23.2	0.00	27.7	0.00
	Control	55.5±4.5	55.6±4.5	0.3	0.71		

DISCUSSION

The aim of this study is evaluating the effect of corrective exercises with vibration (whole body vibration machine) on forward head and round shoulder posture. The result of this study indicates a significant effect of whole body vibration exercise machine on forward head and round shoulder deformity, which was consistent with the study conducted by Morningstar and Jockers (2009).

Implementation of the present research focused on muscles involved with forward head and shoulder posture deformity, which was designed and performed based on the theory of Vladimir Janda and Brugger's cogwheel mechanism (Page et al., 2009). Many researchers also used these exercises and have confirmed their effectiveness. The significant influence of routine exercises (without vibration) was consistent with research conducted by Ruivo et al. (2016), Seidi (2014), Bae et al. (2016).

The main objective of this study was to investigate the effects of vibration with corrective exercises that resulted from high effects of this kind of practice. We will continue to explain the effects of vibration. One of the main effects of this device (WBV) is on muscle coordination (Fontana et al., 2005). Those who have overcoming a specific muscle on an antagonist muscle are (a part is nerve facilitated and the other is nerve inhibited) affront enters inconsistently to both sides. When by vibration from both sides of the joint (agonist and antagonist), neural input enters the central nervous system, this centre will compare messages and then send a balanced affront to both sides. So, neuromuscular coordination will take place between the agonist and antagonist muscles (Fontana et al., 2005, Albasini et al., 2008, Cardinal and Bosco, 2003). The theory of muscle coordination indicates preparation of motor neurons in an operative group of muscles and joints to perform and be compatible with the environment. Moreover, an increase in coordination and integration of motor units, co-contraction of synergists, and inhibiting of antagonist muscles. (Cardinal and Bosco, 2003). The higher central nervous system, through a long loop with higher coordination of this order, and also simultaneous contraction of synergistic muscles (Albasini et al., 2010) supports and improves this action which is performed during vibration activation. (Fontana et al., 2005). The theory of improving the coordination between muscles and remodelling of the subsequent neuromuscular vibration is observed and reported in some studies (Arora and Grenier, 2013). It is necessary to note that these exercises focus on improving the strength of scapula retractors and flexibility of pectoralis, major and minor. In theory, the concept of WBV is based on activating muscles spindles. Muscles spindles cause feedback by muscle stretching in gamma afferent neurons. This induced response in gamma afferent neurons through the gamma ring, by sending it to the cellular body of alpha neurons, causes stimulation and an increase in the fire rate of muscular fibres. This action is known as alpha-gamma simultaneous activity. (Shinohara et al., 2005). The vibration applied on tendons and muscles causes a strong stimulation in muscle spindles and a deterrence of the Golgi tendon organ and, consequently, leads to spontaneous inhibition. (Yan et al., 2012). The primary end of muscle spindles is more sensitive than the secondary end and the Golgi tendon organ (Cardinale and Pope, 2003). The stimulation caused by vibration is not only received by muscular spindle, but also by skin and other joints. (Pollock et al., 2011). Increasing the sensitivity of muscle spindles can improve neuromuscular responses. (Lienhard et al., 2015). Vibration increases the stretching reflection ring through activating the primary end of muscle spindles and can cause contraction of agonist muscles and inhibit antagonist muscles. The tensile strain and tendon and muscle combination condition is determined by dominant reflections. Because of the initial tension, concentric muscle contraction increases, stimulant responses of muscle spindles increase deterrents and Golgi tendon. Vibration can further cause more stimulating responses at the end of the secondary end of muscle spindles, and Golgi tendon organs. The joint, skin, and the secondary end receive vibration stimulation which can increase neural activity of the primary end by gamma neuron activity. (Albasini et al., 2010, Wakeling et al., 2002).

It is stated that vibration applied on muscles can cause an increase in blood flow. Blood flow increase creates thermal effects like vasodilation of skin vessels and deep veins which increase though the warmth generated in muscular fibres. Moreover, by stimulation of vibration, muscle temperature is increased due to tissue friction, which is followed by an increase in blood flow of the muscle, and probably, plasticity changes in muscle tissue. (Verschueren et al., 2011). It is likely that the effects of vibration on flexibility can cause an improvement in muscles involved with these two deformities and can improve them.

CONCLUSION

The results of this study indicate a significant effect of corrective exercises with vibration on these deformities. It is possible that using this vibration device, due to the impact specifically on motor units, can be a proper method for improving forward head and round shoulder posture. In conclusion, it must be said that despite the outcome of the investigation and limitation of similar research (regarding vibration), there are still a lot of uncertainties regarding whole body vibration, the best design of this type of training and the physiological effects.

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EFEKAT KOREKTIVNE VJEŽBE SA VIBRACIJOM NA DRŽANJE GLAVE POMAKNUTE PREMA NAPRIJED I POGNUTA RAMENA

Svrha ovog istraživanja je proučiti efekat korektivne vježbe sa vibracijom na držanje glave pomaknute prema naprijed i pognuta ramena. Metoda korištena u istraživanju je polueksperimentalne prirode, a ispitanici su studenti, muškarci (18-27 godina starosti) koji nisu sportisti. 15 pojedinaca je nasumično odabrano da učestvuju u korektivnoj vježbi sa vibracijom, a 15 za učešće u kontrolnoj grupi. Držanje glave pomaknute prema naprijed i pognuta ramena su izmjereni fotografisanjem iz profila. Primjenjeni protokol je bio 10 sedmica, 3 puta sedmično i 30-60 minuta za obavljanje sesije. Prikupljeni podaci su analizirani putem uparenog i T-testa za nezavisne uzorke koristeći program SPSS-21. Rezultati uparenog T-testa su pokazali da postoji značajna razlika u držanju glave pomaknute prema naprijed (P=0,00) i pognutih ramena (P=0,00) prije i poslije 10 sedmica korektivne vježbe sa vibracijom. Također, značajna je i razlika između eksperimentalne i kontrolne grupe nakon testiranja (P<0,05). Trening sa vibracijom se zasniva na aktiviranju mišićnih vretena. Mišićna vretena kreiraju povratne informacije istezanjem mišića γ senzitivnog (aferentnog) neurona. Možemo zaključiti da su korektivne vježbe sa vibracijom imale pozitivan uticaj na ispravljanje držanja glave prema naprijed i pognuta ramena, pa se mogu preporučiti kao vrsta tretmana za pojedince sa ovim problemom.

Ključne riječi: držanje glave prema naprijed, pognuta ramena, vibracija cijelog tijela, korektivna vježba.

Received: February 26, 2017 / Accepted: March 7, 2017
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COMPARING BASIC-MOTOR CAPABILITIES OF STUDENTS IN HIGHER GRADES OF PRIMARY SCHOOL

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ABSTRACT

The main objective of this study is to evaluate statistical significance in the differences between arithmetic means in two generations of JUOŠ "Lukavac Grad" students in Lukavac of the same age. The sample consisted of 123 boys, namely: 65 boys tested in 2010 and 58 boys tested in 2015, aged 14-15. For the purpose of this study, 18 variables were used for the evaluation of basic motor skills. The results shown in this study show that statistically significant differences exist in seven applied variables. Better results for the respondents of the 2010 generation have been achieved in 4 variables (MBFTAR – hand tapping, MBFTAN – foot taping, MFESDM – standing long jump and MFE20V - running 20 m - sprint from high start), while respondents of the 2015 generation achieved better scores in 3 variables (MFLISK - turning the stick over one's head MPGPIK - darts and MBAU2O - standing vertically on both legs with eyes open).

Keywords: boys, differences, anthropological dimensions, T-test.

INTRODUCTION

In physical and health education, the development of motor skills is most often defined as the process of physical training of children and youth. The basic task of physical and physical education (physical exercise) is to raise the natural level of motor abilities of an individual to a higher level that meets different needs. The physical training process is focused on optimization and not on sports maximization in physical and health education. Under the desirable condition in physical and health education, we can mean any progress in the development of motor skills created by the influence of physical exercise, which allows them to progress further to the level when it is no longer possible. The development of motor skills in children has its natural course, more precisely depending on the physical development, the motor skills are also changed. In literature, as a synonym for the term "motor skills" the following are used: physical abilities, fitness, physical properties and physical fitness. Regardless of the different terms used for the term "motor skills", in literature, one is certainly "the level of physical abilities are the magnitudes that characterize the physical (motoric) capabilities of a particular organism" (Arunović, 1992). Motional abilities are those skills that participate in solving motor tasks and are conducive to successful movement, regardless of whether they have been trained or not (Malacko et al., 2000). Milanović (2009) defines motor skills as the ability to realize all kinds of motion. Their basis lies in the efficacy of organic systems, particularly the nerve-muscular, which is responsible for the intensity, duration and regulation of motion. These capabilities enable powerful, fast, long-lasting, precise or coordinated performance of various motor skills tasks. The development of motor skills can be realized through the physical training process, which should be planned, rational, organized and planned and programmed, and then realized and controlled (Findak, 1999). Testing individual motor skills (Gredelj et al. 1975) and their comparison with the existing norms enables us to better understand the abilities of the entire group (class). The main objective of this study is to evaluate statistical significance in

the differences between arithmetic means in two generations of JUOŠ "Lukavac Grad" students in Lukavac of the same age.

METHODOLOGY OF RESEARCH

Sample of respondents

The sample of students included 123 boys (students) attending JUOŠ "Lukavac Grad" in Lukavac, namely: 65 boys tested in 2010 and 58 boys tested in 2015, aged 14-15.

Sample variables

A sample of variables for assessing the basic motor skills of a student consisted of 18 tests that included 6 basic motor space tests (Kurelić et al. 1975): Motion frequency (segmental speed): MBFTAR - hand taping, MBFTAN - foot taping, MBFTNZ - foot taping against a wall. Flexibility: MFLISK - MFLPRK - MFLPRK, MFLBOS - side stance. Explosive Power: MFESDM - long distance jump, MFE20V - Run 20 m - sprint from high start, MFEBML - throwing a medicine ball from a lying position. Coordination: MKOS3M - slalom with three medicine balls, MAGTUP - envelope test, MAGKUS - side steps. Precision: MPGVCN - kicking a vertical target, MPGHCR - horizontal goal shooting, MPGPIK - darts. Equilibrium: MBAP2O – standing across on both legs with eyes open, MBAU2O standing vertically on both legs with eyes open, MBAU1O - standing vertically on one leg with eyes open.

To determine statistical significance of differences in arithmetic means in two generations of students, a T-test for independent samples was used. Data processing was done at the Faculty of Physical Education and Sports in Tuzla. For this purpose, the program "Statistica" 5.0 for Windows and SPSS 12.0 was used.

RESULTS AND DISCUSSION

Table 1 contains data on basic descriptive parameters for the analysed variables and the investigated group of boys: the number of subjects in each sample (N), the arithmetic mean of both (Mean), standard deviation of both samples (Std. Deviation) and the standard error of the arithmetic mean.

Table 1: Group Statistics

Group			Mean	Std. Deviation	Std. Error Mean
MBFTAR	1 (2010)	65	48.3692	6.08422	0.75466
	2 (2015)	58	44.2069	6.86654	0.90162
MBFTAN	1 (2010)	65	39.6462	4.83939	0.60025
	2 (2015)	58	38.6552	5.43398	0.71352
MBFTNZ	1 (2010)	65	22.4769	2.17304	0.26953
	2 (2015)	58	19.3966	2.08537	0.27382
MFLISK	1 (2010)	65	96.7538	21.75505	2.69838
	2 (2015)	58	102.3793	18.86687	2.47734
MFLPRK	1 (2010)	65	42.8308	8.05561	0.99917
	2 (2015)	58	42.2069	8.65267	1.13615
MFLBOS	1 (2010)	65	173.2	14.24474	1.76684
	2 (2015)	58	173.069	13.8499	1.81858
MFESDM	1 (2010)	65	189.9846	23.6111	2.9286
	2 (2015)	58	179.3793	29.8057	3.91368
MFE20V	1 (2010)	65	3.6086	0.25082	0.03111
	2 (2015)	58	3.8791	0.23017	0.03022
MFEBML	1 (2010)	65	83.1077	15.52631	1.9258
	2 (2015)	58	79.5862	17.56994	2.30705
MKOS3M	1 (2010)	65	27.3392	3.7285	0.46246
	2 (2015)	58	27.8693	3.02075	0.39664
MAGTUP	1 (2010)	65	27.1135	2.1223	0.26324
	2 (2015)	58	27.1857	1.89716	0.24911
MAGKUS	1 (2010)	65	12.3966	1.19649	0.14841
	2 (2015)	58	12.2124	0.96359	0.12653
MPGVCN	1 (2010)	65	9.1538	2.77393	0.34406
	2 (2015)	58	8.7759	2.97382	0.39048
MPGHCR	1 (2010)	65	12.7077	4.26	0.52839
	2 (2015)	58	11.8621	3.45115	0.45316
MPGPIK	1 (2010)	65	24.1231	6.436	0.79829
	2 (2015)	58	26.2759	3.74069	0.49118
MBAP2O	1 (2010)	65	4.5192	3.87808	0.48102
	2 (2015)	58	4.6991	5.20477	0.68342
MBAU2O	1 (2010)	65	3.7986	2.05624	0.25505
	2 (2015)	58	5.3995	3.30417	0.43386
MBAU1O	1 (2010)	65	6.0282	4.87394	0.60454
	2 (2015)	58	5.31	3.53992	0.46481

Table 2 contains all the data related to T-test procedures for independent samples. For each variable in the first row, the results are the Equal variances assumed, and the second, inequality of the variance (Equal variances not assumed). The first two columns show the results of Leven's Test for Equality of Variances, its value (F) and significance (Sig.). The following columns show the results of the test of equality of arithmetic means for the two groups: the value of the T-test (t), the number of degrees of freedom (df), the significance of two-dimensional testing of the difference of the arithmetic means (Significance of the 2-tailed) Standard Error Difference, Lower and Upper Interval Limits Confidence 95% (95% Confidence Interval of the Difference (Lower, Upper)).

Based on the obtained results, comparisons of arithmetic means show that statistically significant differences exist in seven applied variables. The boys of the 1st group (generation 2010) show better results in the area of segmental velocity and explosive power, and the boys of the 2nd group (generation 2015) achieved better results in the space of flexibility, precision and balance.

Variables with statistically significant differences in favour of the 1st group (generation 2010) are: MBFTAR - hand taping, MBFTAN - foot taping, MFESDM - standing long jump and MFE20V - running 20 m - sprint from high start.

Variables in which the statistically significance differences are in favour of the 2nd group (generation 2015) are: MFLISK - turning the stick over one's head MPGPIK - darts and MBAU20 - standing vertically on both legs with eyes open.
In comparison with the 2015 generation of students, the 2010 generation achieved better results in the following variables, expressed in percentages: MBFTAR (9%), MBFTAN (14%), MFESDM (6%) and MFE20V (7%).

When compared with the 2010 generation of students, the 2015 generation achieved better results in the following variables, expressed in percentages: MFLISK (5%), MPGPIK (8%) and MBAU20 (11%).
Based on the results obtained, it can be concluded that the trend of motor skills development, with regard to age, is appropriate to the legality of motor skills development. The legality of motor skills development is largely in accordance with the legality of growth and development (Mraković et al., 1996, Horvat and Vulet, 2002, Vraneković et al., 2003, Strel et al., 2010).

Table 2

Variable	Levene's Test for Eq. of Variances		Independent Samples Test					95% Conf.	
			T - test for Equality of Means					Interval of the Difference	
		sig.	t	df	sig. (2-tail)	Mean Difference	Std. Error Difference	ower	pper
MBFTAR	1.13	0.29	3.57	121.00	0.00*	4.16	1.17	1.85	6.47
Eq. var. assum.			3.54	114.70		4.16	1.18	1.83	6.49
Eq. var. not ass.									
MBFTNZ	0.37	0.55	1.07	121.00	0.29	0.99	0.93	-0.84	2.82
Eq. var. assum.			1.06	114.95		0.99	0.93	-0.86	2.84
Eq. var. not ass.									
MBFTNZ	0.12	0.74	8.00	121.00	0.00*	3.08	0.39	2.32	3.84
Eq. var. assum.			8.02	120.35		3.08	0.38	2.32	3.84
Eq. var. not ass.									
MFLISK	0.89	0.35	-1.52	121.00	0.04*	-5.63	3.69	-12.94	1.69
Eq. var. assum.			-1.54	120.91		-5.63	3.66	-12.88	1.63
Eq. var. not ass.									
MFLPRK	0.33	0.57	0.41	121.00	0.68	0.62	1.51	-2.36	3.61
Eq. var. assum.			0.41	116.96		0.62	1.51	-2.37	3.62
Eq. var. not ass.									
MFLBOS	0.01	0.92	0.05	121.00	0.96	0.13	2.54	-4.90	5.16
Eq. var. assum.			0.05	120.09		0.13	2.54	-4.89	5.15
Eq. var. not ass.									

MFESDM	2.65	0.11	2.20	121.00	0.03*	10.61	4.82	1.05	20.16
Eq. var. assum.			2.17	108.43		10.61	4.89	0.92	20.29
Eq. var. not ass.									
MFE20V	0.02	0.89	-6.21	121.00	0.00*	-0.27	0.04	-0.36	-0.18
Eq. var. assum.			-6.24	120.90		-0.27	0.04	-0.36	-0.18
Eq. var. not ass.									
MFEBML	1.42	0.24	1.18	121.00	0.24	3.52	2.98	-2.39	9.43
Eq. var. assum.			1.17	114.57		3.52	3.01	-2.43	9.47
Eq. var. not ass.									
MKOS3M	3.27	0.07	-0.86	121.00	0.39	-0.53	0.62	-1.75	0.69
Eq. var. assum			-0.87	119.93		-0.53	0.61	-1.74	0.68
Eq. var. not ass.									
MAGTUP	0.76	0.39	-0.20	121.00	0.84	-0.07	0.36	-0.79	0.65
Eq. var. assum.			-0.20	121.00		-0.07	0.36	-0.79	0.65
Eq. var. not ass.									
MAGKUS	6.12	0.02	0.93	121.00	0.35	0.18	0.20	-0.21	0.58
Eq. var. assum.			0.95	119.79		0.18	0.20	-0.20	0.57
Eq. var. not ass.									
MPGVCN	0.01	0.94	0.73	121.00	0.47	0.38	0.52	-0.65	1.40
Eq. var. assum.			0.73	117.04		0.38	0.52	-0.65	1.41
Eq. var. not ass.									
MPGHCR	3.68	0.06	1.20	121.00	0.23	0.85	0.70	-0.55	2.24
Eq. var. assum.			1.22	119.93		0.85	0.70	-0.53	2.22
Eq. var. not ass.									
MPGPIK	22.35	0.00	-2.23	121.00	0.02*	-2.15	0.96	-4.06	-0.24
Eq. var. assum.			-2.30	104.77		-2.15	0.94	-4.01	-0.29
Eq. var. not ass.									
MBAP20	1.11	0.29	-0.22	121.00	0.83	-0.18	0.82	-1.81	1.45
Eq. var. assum.			-0.22	104.60		-0.18	0.84	-1.84	1.48
Eq. var. not ass.									
MBAU20	3.67	0.06	-3.26	121.00	0.00*	-1.60	0.49	-2.57	-0.63
Eq. var. assum.			-3.18	93.28		-1.60	0.50	-2.60	-0.60
Eq. var. not ass.									
MBAU10	2.09	0.15	0.93	121.00	0.35	0.72	0.78	-0.82	2.25
Eq. var. assum.			0.94	116.37		0.72	0.76	-0.79	2.23
Eq. var. not ass.									

CONCLUSION

The results obtained by testing the difference between the arithmetic means pertaining to two student generations of JUOŠ "Lukavac Grad" in Lukavac, who are 14-15 years old, measured in 2010 and 2015, indicate that the older generation (tested in 2010) showed better results in the field of motion and explosive power, while the generation (tested in 2015) achieved better results in the field of flexibility, precision and balance. The statistically significant differences were not found in the area of coordination. Given the fact that this research was carried out on a relatively small sample and a narrower geographical footprint, the obtained results cannot be considered generalized. For these reasons, future research should be more comprehensive and conducted on larger (wider) areas, where the differences within the motor space would be much clearer. There is a need to improve an active lifestyle, increase physical activity outside school, and promote other health and hygiene habits. Therefore, an increasingly difficult and responsible task of helping young people create exercise habits for physical exercise is up to us, the pedagogues of physical and health education, as well as all other social factors dealing with this issue. By doing so, they will help them overcome their difficulties by providing them with normal biological and psychosociological development and a more satisfying life in today's increasingly demanding social environment.

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KOMPARACIJA BAZIČNO-MOTORIČKIH SPOSOBNOSTI KOD UČENIKA VIŠIH RAZREDA OSNOVNE ŠKOLE

Osnovni cilj ovog istraživanja je da se procijeni statistička značajnost u razlikama aritmetičkih sredina kod dvije generacije učenika JUOŠ "Lukavac Grad" u Lukavcu iste starosne dobi. Uzorak ispitanika obuhvatio je 123 dječaka, i to: 65 dječaka testiranih 2010. godine i 58 dječaka testiranih 2015. godine, uzrasta 14-15 godina. Za potrebe ovog istraživanja korišteno je 18 varijabli za procjenu bazično-motoričkih sposobnosti. Rezultati do kojih se došlo u ovom istraživanju pokazuju da statistički značajne razlike postoje u sedam primijenjenih varijabli. Bolje rezultate ispitanici generacije 2010. postigli su u 4 varijable (MBFTAR – taping rukom, MBFTAN – taping nogom, MFESDM – skok u dalj iz mjesta i MFE20V – trčanje 20 m – sprint iz visokog starta), dok su ispitanici generacije 2015. bolji rezultat postigli u 3 varijable (MFLISK – iskret s palicom MPGPIK – pikado i MBAU20 – stajanje uzduž na dvije noge otvorenih očiju).

Ključne riječi: dječaci, razlike, antropološke dimenzije, T-test.

Received: June 1, 2017 / Accepted: June 15, 2017
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A COMPARISON BETWEEN VIDEO AND POINT LIGHTS DISPLAYS TO LEARN A NOVEL SKILL

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ABSTRACT

The purpose of this study was to compare a provided video demonstration and point lights display to learn a novel skill. For this purpose, 24 participants were divided into three groups including video, point lights display and control. Participants, in the acquisition phase, should perform 30 trials. According to the previously stated classification, demonstration groups observed the corresponding film 5 times before the first trial. They also observed the model before each throw in the subsequent trials. The control group received only verbal instructions. The accuracy and variability of intra limb coordination was calculated in relation to the model. The results showed that there was no difference between the groups movement accuracy measure, but the experimental groups performed more like the model than the control group in intra limb coordination measure. However, there was no difference among experimental groups. These results were interpreted in relation to the role of task constraints.

Keywords: observational learning, video demonstration, point lights display, visual perception perspective.

INTRODUCTION

For the first time, researchers in the field of psychology investigated the process of observational learning (Bandura & Walters, 1977). Although research history in the field of learning through observation goes before Bandura, now this process is known due to the theory he developed (Bandura, 1986).

Bandura believes that a person creates a cognitive representation by observing the actions of other people, so that they use the mental representation for the next performance (Bandura, 1986; Bandura & Walters, 1977). Nowadays, researchers seek ways to improve the process of creating representation by observation. Meanwhile, some investigators believe that showing a model in different ways (video or point lights display) can lead to different representations and as a result, the learning rate can be different (Johansson, 1973; Rodrigues, de C. Ferracioli, & Denardi, 2010; Deirdre Scully & Carnegie, 1998).

Johansson believes that, if the pattern is displayed by point lights, motion detection occurs easier, so that the provision of pattern with this method is more effective than video display, due to the elimination of additional structural information in showing point lights compared to video display and highlighted kinematic information in this type of presentation (Johansson, 1973). In support of this claim, the visual perception perspective believes that, when the pattern is seen by an observer, relative information is used by the observer for performing the next movement (DM Scully & Newell, 1985).

Given that relative kinematic information has been highlighted in point lights display, it is likely that the relative data is used during observation in an easier way in this type of demonstration. This can cause superiority of presenting a model using the point lights display (Al-Abood, Davids, Bennett, Ashford, & Marin, 2001; Horn, Williams, & Scott, 2002).

Comparisons between the point lights display and video model have been conducted by different researchers. For example, it was indicated that presenting dance movement in the form of the point lights leads to better learning compared with the video model (Deirdre Scully & Carnegie, 1998). This superiority has been also observed in learning basketball dribbling (Romack, Bardy, Bootsma, & Guiard, 1995). Although initial research indicated

superiority of point lights display compared with the video model, recent research in this context differ from the previous findings. For example, researchers showed that providing information by point lights does not have any superiority compared to the video model in the underhand dart throwing (Al-Abood et al., 2001).

It was also shown that there was no difference between the point lights display and video demonstration to learn the soccer chip skill (Horn et al., 2002). Despite these findings, the comparison between these two types of demonstrations was done in a throw of cricket game (Breslin, Hodges, Williams, Curran, & Kremer, 2005). The results demonstrated that there was no difference between these two types of modelling, both in the variable of movement accuracy and intra limb coordination. It was argued that perhaps the type of used information during observational learning is different from what is believed in visual perception perspective (Breslin, Hodges, Williams, Kremer, & Curran, 2006). Also, it was shown that there was no difference between video and point lights displays by the basketball free throw (Ghorbani & Bund, 2016). This is not the end of presenting contradictory results. For instance, it was shown that providing information by video modelling in ballet leads to better learning in comparison to point lights display (Rodrigues et al., 2010).

It was also shown that video demonstration in crouch start results in better learning in comparison with point lights display. These contradictory results have some major reasons. One of the main reasons can be the type of the applied task in these studies. It is believed that tasks with low complexity (like soccer chip, dart throwing) cannot represent the observational learning process (Williams, Davids, & Williams, 1999). This could be because their movement patterns could be learned early in practice and people could have them in their movement repertories. In most of these studies (Al-Abood et al., 2001; Farsi, Bahmanbegloo, Abdoli, & Ghorbani, 2016; Ghorbani & Bund, 2016), the initial stage of learning was not separated properly from the other stages and most of them have compared a long block with other blocks, while it is believed, in visual perception perspective, (DM Scully & Newell, 1985) that relative information is used in the early stage of learning. Also, in many of the above mentioned studies (Al-Abood et al., 2001; Farsi et al., 2016; Horn et al., 2002), the type of the measurement used for comparison of groups is a single measure, or it is based on a person as a representative of the group, in which this type of measurement cannot reflect the real changes made in the entire group.

Accordingly, this study attempted to separate various stages of acquisition in a smaller way by using a novel task, as well as to make a comparison between the two types of displays with a continuous evaluation of the motor coordination pattern in all the group members, which can contribute in eliminating ambiguities for this field of research.

METHODOLOGY

Participants

Participants in the study included 24 right-handed male students (their age ranges between 20 and 30) who had no previous experience in the task. They were randomly divided into three groups including video, point lights and control. Furthermore, individual consent forms were obtained from all the participants before the study started.

Tasks and tools

In this study, a reversed throw of a baseball was used as a target task. Typically baseball throwing is done with the opposite arm and leg and throwing is carried out by forehand, but the used throw in this research is done by positioning the hand and foot on the same side in the form of a backhand. The assignment has been modelled from the previous investigations (Horn, Williams, Hayes, Hodges, & Scott, 2007) and it was used in such a way that it would be as novel task for the observer as possible and the involved number of degrees of freedom would be higher than those of the previous task.

In order to record the movement accuracy, a box with dimensions of 2 x 2 m, which was filled with soft and wet sand, was used to determine the landing position of the ball.

The subjects were given a standard baseball to perform the task. Then, they were asked to throw the ball from a distance of 5 meters towards a red cross that was situated in the middle of the box. The distance of the landing position in relation to the edge of the cross sign was measured in centimetres. An EPSON projector and a screen with dimensions of 2 × 2 m were utilized to display the demonstrations. Also, a SIMI motion analysis system with 6 high-speed video cameras, which captured the coordinates of 17 reflective markers that were placed on the body of the participants was used in order to record the kinematics of the movement patterns.

Data collection method

First, an adult (24 years old) was asked to practice the mentioned task for 5 days (200 trials each day) and to provide the model. On the final day, after practice attempts (ten-minute break), 17 reflective markers were placed on the model's body in the

following order to record the kinematics of the movement pattern. The arrangement of markers was as follows: the acromion process (shoulder), lateral epicondyle (elbow), ulnar styloid (wrist), the meta carpal head (finger), the greater trochanter (hip) the lateral condyle of the femur (knee), the lateral malleolus (ankle), the distal head of the fifth metatarsal (toe) and one on the centre of the forehead (Breslin et al., 2006; Hayes, Hodges, Huys, & Williams, 2007). Then, one of the attempts, in which the ball exactly hit the middle of the target, was filmed and it was used as a video model. Point lights display movie, as well as video film were provided using the SIMI MOTION software. These two films were exactly produced from one video. Therefore, the information contained in them, was also quite similar. The only difference was the method of presenting the information. Both videos were quite similar in terms of time and the duration of their playing time was approximately six seconds. In the acquisition phase, a 5-min rest was devoted to participants in order to adapt to laboratory conditions at first, and then, similar to the model, reflective markers were placed on their bodies. In order to overcome the probable negative effect of showing point lights display (Hayes et al., 2007) before the main film of movement is presented, the film of point lights from a series of movements like running, walking and jumping were shown to individuals and then video films of the same movements were demonstrated to them. It should be noted that these actions had no resemblance to the mentioned movement (Breslin et al., 2006; Hayes et al., 2007). The video group received model videos without any verbal information, while the control group only received recorded verbal instructions about the way of throwing. The participants were requested to perform 30 trials (three blocks, 10 in each and a 2-minute rest between each block) in the acquisition phase. Before the first attempt, the model's film (based on the previously mentioned grouping) was displayed 5 times and it was presented once in subsequent attempts. All the groups were instructed to have an equal emphasis on the target and reproducing the model's movement pattern (Breslin et al., 2005; Breslin et al., 2006) The subjects were called to the laboratory 24 hours after the acquisition phase and they were asked to perform 10 attempts as a retention test. At this stage, the subjects were not given any information.

Statistical Methods

Accuracy In this study, the distance between the location where the ball landed and the desired target was used as the accuracy of movement. Data related to this variable in the acquisition phase was analysed using a mixed analysis of variance (ANOVA) with 3 (groups) × 3 (blocks) with repeated measures on the last factor. The data was then analysed in the retention phase using a one-way ANOVA.

Kinematics To provide an index of similarity of the participants' intra- limb coordination in comparison with the model, a modified version of a normalized root mean squared error (NORMS) was used (Sidaway, Heise, & SchoenfelderZohdi, 1995). In this approach, the model's trace was used as a criterion and the disparity of each trial was calculated from model's criterion trace. Then, this score was normalized for a number of trials and excursion. This approach was called normalized root mean squared difference (NORM-D) (see Horn et al., 2005). A smaller NORM-D score shows a close approximation to the model's movement trace. Data have been collected for a limited number of attempts including the first three trials of the first block, 8 to 10 for the three final trials of the first block, 18 to 20 for three final trials of the second block and 28 to 30 for three final trials of the third block during acquisition. The trials 1-3 and also 8-10, in the retention phase, were considered as two retention blocks. Before kinematics analysis, the start and end points of movement were standardized. The start point was determined as initiation of right elbow flexion and the end point was determined as maximum extension of right elbow. The data were smoothed with a recursive 4th order Butterworth filter with a cut-off frequency of 7 Hz. A linear interpolation was performed to normalize this period to 100 data points (Winter, 2009) enabling comparisons across trials and with the model. Mixed ANOVA 3 (group) × 4 (blocks) with repeated measures on the last factor was used to analyse kinematic data in the acquisition phase. During retention, the data was analysed using a mixed ANOVA 3 (groups) × 2 (blocks) with repeated measures on the last factor.

RESULTS

In cases where the default of the Mauchly's test of sphericity was not confirmed, Greenhouse-Geisser correction was implemented. Accuracy of the throw Accuracy of the group's performance at different stages is shown in Figure 1.

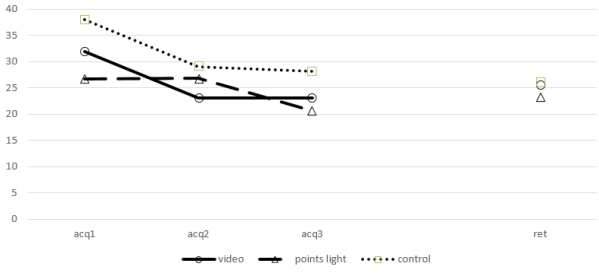

Figure 1: Diagram of the groups' accuracy in different stages

The results of ANOVA for the acquisition stage showed that the main effect of group, F (2, 21) = 3.7، p = 0/04، η^2_p = 0.26 and also the main effect of block F (1.48, 31.17) = 8.72, p = 0.002, η^2_p = 0.29 are significant but their interaction was not significant, F (2.96, 31.17) = 1.12، p = 0.35, η^2_p = 0.09. Post- hoc test was conducted for the main effect of group in which its results showed that there was a significant difference between practical groups (video and point light) and the control one (for all p <0.05), but there was not any difference between the video group and point lights demonstration (p> 0.05). Mean comparisons indicated that video and point lights groups, compared to the control group, have committed fewer errors (Averages for video = 26.5, points of light = 24.70, control = 31.77).
The post-hoc test was also carried out for the main effect of blocks. The results showed that the second and third blocks were significantly different from the first block, all P < 0.05, but there was no significant difference between the second and third blocks (p > 0.05). Mean comparisons demonstrated that the groups had higher accuracy in the second and third blocks than the first block (Means: first block = 32.23, second block= 26.33, and third block = 23.95).
The results of the ANOVA test in the retention phase showed that the main effect of groups was not significant, F < 1.

Intra limb coordinationt

Figure 2 reveals the intra limb coordination variability in relation to the model for all groups.

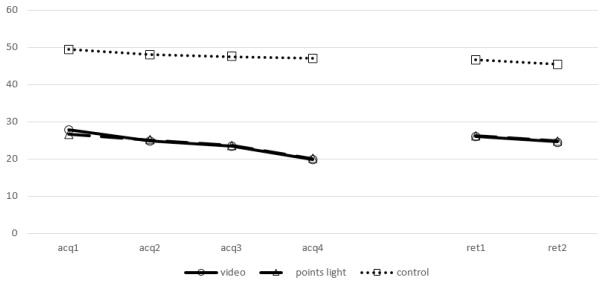

Figure 2: Intra limb coordination variability in relation to the model

The results of ANOVA for the acquisition phase indicated that the main effect of group, F (2, 21) = 58.21, p = 0.0001, η^2_p = 0.84, and also the main impact of blocks F (1.81, 38.09) = 20.27, p = 0.0001, η^2_p = 0.49, are significant but there was no significant interaction between the two factors, F (3.62, 38.09) = 1.9, p = 0.09, η^2_p = 0.15. The post-hoc test for the main effect of group showed that there was no significant difference between video and light points groups, P > 0.05, but both of them had a significant difference with the control group (all P < 0.05).

A mean comparison showed that the experimental groups compared to the control group had less variability in their intra limb coordination (means, video = 23.99, points light = 23.90, control = 48.03).An additional post-hoc test was conducted for the main effect of block, in which the results indicated that the difference between the second and third blocks is only insignificant (P > 0.05), while there were significant differences for the rest of the paired comparisons (all P < 0.05). Means Comparison demonstrated that the groups became more similar to the movement pattern of the model with increasing the rate of practice (means: first block = 34.63, second block = 32.69, third block = 31.55 and fourth block = 2.29).The results of ANOVA in the retention test revealed that the main effect of group, F (2, 21) = 30.42, p = 0.0001, η^2_p = 0.74 and also the main effect of block, F (1, 21) = 30.72, p = 0.0001, η^2_p = 0/59 were significant, but the interaction effect between the two was not statistically significant, F < 1.
The post-hoc test was performed for the main effect of group and the outcomes indicated that video and point lights groups had a significant difference with the control group (all p < 0.05), but there was not any significant difference between video and point lights groups, p > 0.05. The means comparison showed that video and point lights groups, compared to the control group, have acted more like the model (means: video = 25.31, points light = 25.56, control = 46.07). Means comparisons for the main effect of block showed that the groups performed more like the model in the second block than in the first block (Means: first block = 32.98, second block = 31.64).

DISCUSSION AND CONCLUSION

The aim of this study was to compare the video demonstration and point lights displays as two different ways of observational learning. For this purpose, a novel back hand throwing was selected as the goal task. The results showed that both video and point lights groups had better accuracy than the control group during the acquisition phase, but these effects were not observed during retention, there was no difference between the groups in the retention phase. These findings are inconsistent with some results from the previous studies (Al-Abood et al., 2001; Breslin et al., 2005; Horn et al., 2002). In these studies, the difference was not observed between the groups in the accuracy measure during the acquisition phase, but it was shown, in this research, that the groups significantly improved more than the control one. One of the probable reasons can be related to sensitivity of the scoring system in previous research. In most of these research, a discrete scoring system was used, in which this system cannot properly show the difference between the groups (Hayes et al., 2007), but in this study, a scoring system based on centimetres was used,

which is more sensitive and demonstrates the difference between the groups in a better way. What is similar in the current study to other research is the lack of difference between video and point lights groups.

This would be due to several reasons; one possible reason could be related to the need of achieving an external target in the task. Some argue that participants emphasize on the access to an external target when observing an action with it and they do not pay much attention to the model (Hayes, Ashford, & Bennett, 2008; Hayes et al., 2007; Wohlschläger, Gattis, & Bekkering, 2003). For this reason, it is possible that the groups would aim mainly to achieve an external target and show similar performance. Another probable reason could be related to the roof effect in this task, so that, given to the limited number of practice trials in this study, it is likely that achieving the target more accurately was not possible. This would cause similar performance of the groups.

The results in the kinematic measure also indicated that the experimental groups performed more like the model in the acquisition phase compared to the control group, but no significant difference was observed between the video and point lights groups. These effects were also maintained in the retention phase. The results of this study are consistent with some of previous findings (Breslin et al., 2005; Horn et al., 2002), while they are inconsistent with some of the other studies (Farsi et al., 2016; Rodrigues et al., 2010).

In those studies where a significant difference was not observed between video and point light groups, goal directed tasks were used (like current study). As it was also previously mentioned, some researchers believe that, if the task requires achieving an external target in observational learning, the observers embed their first priority to meet the external target regardless of the type of information (Hayes et al., 2008; Wild, Poliakoff, Jerrison, & Gowen, 2012; Wohlschläger et al., 2003). It is likely that, in this study, throwing the ball to hit the target would be the first goal of participants and they would ignore the provided information. But in research, in which the difference between the two types of demonstrations has been observed, the tasks that were applied do not have an external target and they are more process-oriented tasks (Farsi et al., 2016; Rodrigues et al., 2010; Romack et al., 1995).

Moreover, the reason that both experimental groups, compared to the control group, had better performance could be due to imitation of the overall strategy to perform the task. It is believed that observers can obtain general information related to the movement strategy in addition to receiving information about the movement pattern in a demonstration (Magill & Anderson, 2007). Accordingly, it is possible that groups which have received the model's information (video and point lights), would have achieved a better way to do the task (equally).

In general, the results revealed that there is no difference between video and point lights displays. Based on these results and inferences from previous research, it seems that the existence of an external target in a task is a significant factor in the existence of difference among various types of modelling. This means that, if the task requires achieving an external target, it is likely that the observers set their first priority to achieve the external goal. However, in cases where the task does not include an external target to reach, the participants emphasize on imitation of the model's movement pattern. It is suggested that the two types of tasks (with and without an external target) are used simultaneously in future research to further test the accuracy of this argument.

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POREĐENJE KORIŠTENJA VIDEO I SVJETLOSNIH POKAZIVAČA ZA UČENJE NOVE VJEŠTINE

Svrha ovog istraživanja je poređenje video prikaza i prikaza putem svjetlosnih pokazivača za učenje nove vještine. U svrhu istraživanja, 24 učesnika su podijeljena na tri grupe i to video, svjetlosni pokazivač, te kontrolna. U fazi usvajanja, učesnici bi trebali izvršiti 30 testova. Grupe kojima se sadržaj prikazivao su 5 puta posmatrale odgovarajući film na osnovu gore navedenog grupisanja prije prvog testa. Oni su također posmatrali model prije svakog bacanja u narednim testovima. Kontrolna grupa je dobila samo usmene upute. Tačnost i varijabilnost koordinacije unutar ekstremiteta su izračunate u odnosu na model. Rezultati su pokazali odsustvo razlike između mjerenja preciznosti kretanja grupa, ali su eksperimentalne grupe bile sličnije modelu od kontrolnih grupa kada je u pitanju mjerenje koordinacije unutar ekstremiteta. Međutim, razlika nije uočena kada su u pitanju eksperimentalne grupe. Ovi rezultati su tumačeni u odnosu na ulogu ograničenja u izvedbi zadatka.

Ključne riječi: učenje posmatranjem, video prikaz, prikaz putem svjetlosnih pokazivača, vizualna percepcija i perspektiva.

Received: June 1, 2017 / Accepted: June 15, 2017
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