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SADRŽAJ

DEAR READER,

This issue contains scientific papers from 15 countries and 4 continents that are written by researchers who come from 17 countries and 5 continents.

Continuity in publishing scientific papers from the field of sports that promote new values and results is also maintained in this issue of the magazine, which is indicated by an overview of published papers in the following areas: two papers from sport psychology, one paper from biomechanics, one from sports nutrition, seven papers from transformation processes, one deals with new technologies in sports, three come from the field of sports management, two from sports medicine and one paper from kinesiological education.

Just as in previous issues, the research conducted by young scientists have been included in this issue, whereby we strive to promote their knowledge and quality through our magazine. We are thankful to our Editorial Board members for their devoted work, promptness and a responsible approach that demands originality and the quality of authored works thereby ensuring the magazine's value and recognition.

Our Editorial board deeply believes that the development of sports disciplines is only possible through the development of scientific achievements and their implementation in practice. The exchange of results, ideas and new scientific findings through our magazine contributes to an advancement of scientific thought, which results in indicators of shifting boundaries and creating new sports systems accompanied by the usage of advanced technology and its implementation in the field of sports.

Changing rules in sports disciplines, implementing and using new equipment, adapting the environment according to different needs of athletes, the appearance of new techniques that keep up with new technologies and many other factors impact the constant need for monitoring, researching and detecting obstacles that stand in the way of accomplishing the best results.

Understanding new technologies in sports is no longer a privilege of major sports milieus, but a need without which it is not possible to keep up with trends in sports and strive towards successful, top results. Promoting the results through papers in our magazine is not only the quickest way to reach our readers, but also an obligation to maintain trust and the quality that will satisfy the readers' needs and expectations. Our wish is to include an even wider auditorium and new authors in the following issues so as to publish more diverse, affluent, interesting and higher quality editions.

We invite you, readers, to become a part of our team and participate in our work so that, together, we could contribute to changes in the world of sports in a creative and innovative way.

Nihad Selimović, MD, MSc
Editor in chief

DRAGI ČITATELJU,

U ovom broju nalaze se naučni radova iz 15 zemalja sa četiri kontinenta, realiziranih od strane istraživača koji dolaze iz 17 zemalja i sa pet kontinenata.

Kontinuitet u objavljivanju naučnih radova iz oblasti sporta koji promovišu nove vrijednosti i rezultate zadržan je i u ovom broju časopisa što pokazuje pregled objavljenih radova po oblastima: dva rada iz sportske psihologije, jedan rad iz biomehanike, jedan iz sportske prehrane, sedam radova iz trensformacionih procesa, jedan obrađuje nove tehnologije u sportu, tri su iz sportskog menadžmenta, dva iz sportske medicine i jedan rad iz kineziološke edukacije.

Kao i u prethodnim izdanjima, istraživanja mladih naučnika uključena su i u ovaj broj, čime nastojimo promovisati njihovo znanje i kvalitetu kroz naš časopis. Zahvalni smo članovima recenzentskog odbora na predanom radu, ažurnosti i odgovornom pristupu u kojem se zahtjeva orginalnost i kvalitet autorskog djela čime se osigurava vrijednost časopisa i njegova priznatost.

Naš urednički odbor duboko je uvjeren da je razvoj sportskih disciplina jedino moguć kroz razvoj naučnih dostignuća i njihovu implementaciju u praksi. Razmjena rezultata, ideja i novih naučnih saznanja preko našeg časopisa doprinosi unaprjeđenju naučne misli što za rezultat ima pokazatelje o pomjeranju granica i stvaranja novih sportskih sistema uz korištenje napredne tehnologije i njene primjene u oblasti sporta.

Izmjene pravila u sportskim disciplinama, primjena i korištenje nove opreme, prilagođavanje okruženja prema različitim potrebama sportista,pojava novih tehnika koje prate nove tehnologije i mnogo drugih faktora, utiču na stalnu potrebu za praćenjem, istraživanjem i otkrivanjem prepreka koje stoje na putu ostvarivanja najboljih rezultata.

Poznavanje novih tehnologija u sportu više nije privilegija velikih sportskih sredina već potreba bez koje nije moguće pratiti sportska kretanja i težiti ka uspješnim, vrhunskim rezultatima. Promovisanje rezultata preko radova u našem časopisu je nabrži put do naših čitatelja ali i obaveza da održimo povjerenje i zadržimo kvalitet koji će zadovoljiti potrebe i očekivanja čitatelja. Naša je želja da u narednim izdanjima uključimo još širi auditorij i nove autore, kako bi svako sljedeće izdanje bilo raznoliko, bogatije, kvalitetnije i zanimljivije.

I Vas, čitatelje, pozivamo da budete dio našeg tima i da učestvujete u našem radu kako bi svi zajedno doprinosili promjenama u svijetu sporta na kreativan i inovatina način.

Mr.sci.dr.Nihad Selimović
Glavni urednik

INVESTIGATION OF THE PSYCHOLOGICAL MOTIVATING FACTORS BEHIND COMPETITION (MASTERS SPORT) IN THE CONTEXT OF BODY MASS INDEX

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ABSTRACT

The World Masters Games (WMG) is recognised by the International Olympic Committee and is the largest international sporting competition in terms of participant numbers. The aim of this study was to investigate body mass index (BMI) in the context of the psychological motivations for competition; potentially, this could assist with promotion strategies for masters sport. In context of the global obesity epidemic, investigating this under-investigated population might further the understanding of the nexus between aging, physical activity and obesity. An online survey investigated Sydney WMG participants. In total 4963 masters athletes (51.4% male) aged 25 to 91 years (mean=51.1, SD±9.6) were analysed. Psychological questions focused on factors thought to promote participation. Bootstrapping provided robust estimates of standard errors and 95% confidence intervals (CI) of mean values. The main motivating factors for obese individuals were "to socialise with other participants" (mean score 5.92/7), "to compete with others" (mean score 5.34/7) and "to improve health" (mean score 5.20/7). Bootstrapping indicated factors differed across BMI classes. The factor "to socialise with other participants" for obese WMG athletes (CI 5.82-6.05), was higher than for overweight (CI 5.67-5.80) or normal (CI 5.57-5.70) classification masters athletes. The variable "to improve my health" also differed across BMI, being lower for obese (CI 5.07-5.35), than overweight (CI 5.49-5.64) or normal (CI 5.57-5.71). Obese athletes were more likely to be motivated to compete to socialise and less by competition than other athletes. The factor "to reduce my weight" correlated (p=0.27, p<0.001) with BMI, re-iterated by CI ranges for obese (3.46-3.77), overweight (3.37-3.55) and normal (2.51-2.65), demonstrating a decreased focus on this factor for those with normal BMI. Despite the correlation between BMI and the factor "to reduce my weight", for obese individuals "to socialise with other participants" was the highest ranked factor. Strategies to increase masters sport participation for obese individuals should focus on socialisation with other participants.

Keywords: Quetelet Index, sport psychology, participation, masters sport.

INTRODUCTION

As defined by Raeburn and Dascombe, 2008, masters athletes are those systematically training for and competing in organised sporting events designed specifically for older adults.

The minimum qualifying age for competition in masters sport, varies by sport (Raeburn and Dascombe, 2009), gender and different tournaments. Most masters athlete events structure competition between athletes of similar age ranges where possible. Thousands of masters athletes participate quadrennially in the World Masters Games (WMG). Recognised by the International

Olympic Committee, it is the largest international sporting competition in terms of participant numbers. In 2009, the Sydney WMG attracted 28,089 competitors representing 95 countries, competing in 28 sports (Sydney 2009 World Masters Games Committee, 2009). This cohort of middle to older-aged adults remains under investigated with regards to various measures of health. With a need for multifaceted solutions to the global obesity epidemic (Mazzeo, Vetrano, Nocerino & Carpino, 2010) investigating special populations such as those competing in sport at mature-older ages may further the understanding of the nexus between aging, physical activity and obesity.

Previous research on WMG competitors has been conducted on health (Climstein et al., 2011; DeBeliso et al., 2011; Walsh et al., 2012, DeBeliso et al., 2014; Climstein et al. 2016), injury incidence in the lead up to the tournament (Walsh et al., 2011a; Walsh et al., 2011b; Walsh et al., 2011c) and psychological motivations to compete (Adams et al., 2011; Heazlewood et al., 2011; Sevene, 2012; Heazlewood et al., 2015; Heazlewood et al., 2016a; Heazlewood et al., 2016b) at this competition. Provisional analysis of the athletes' BMI (Walsh et al., 2011d; Walsh et al., 2011e; Walsh et al., 2011f; Walsh et al., 2013) has shown promising trends in terms of reduced obesity prevalence in WMG athletes.
Prior literature reported those sport psychological constructs of health, physical fitness, mental health states, and social dimension factors in sport that were associated with participation in sport and physical activity based on responses (7846 athletes) from the 2009 World Masters Games in Sydney (Heazlewood et al., 2011). Provisional analysis independent of participant BMI had indicated the most significant factors related to participation, and with this cohort of masters athletes the factors were the socializing environment of sport, getting physically fit and improving competitive personal best performances (Heazlewood et al., 2011).

The Motivations of Marathoners Scales (MOMS) (Masters, Ogles, & Jolton, 1993) is used to gauge the importance of a range of psychological factors in determining sports participation. The age ranges present in the research used to develop the MOMS survey instrument had significant overlap with age ranges of participants at the 2009 WMG and items identified in the MOMS have been demonstrated in other studies (Ogles, Masters 2003; Havenar, Lochbaum, 2007; Ruiz, Zarauz Sancho, 2011) as important motivational constructs, with significant relevance (Heazlewood et al., 2012; Heazlewood et al. 2015; Heazlewood et al., 2016a; Heazlewood et al., 2016b) to masters athletes.

The MOMS psychometric instrument assessed participant motivation based on nine constructs/factors using factor scores from a 56 item seven Likert type survey instrument measuring motivations to participate. The nine factors were health orientation, weight concern, personal goal achievement, competition, recognition, affiliation, psychological coping, life meaning and self-esteem. The most significant factors related to participation in the 2009 WMG cohort were the socializing environment of sport, getting physically fit and improving competitive personal best performances (Heazlewood et al., 2011).
The instrument was based upon a series of 56 questions and scored on a seven point Likert scale, where masters athletes were requested to rate each of the following items according to the scale below in terms of how important it is as a reason for them participate in their sport. A score of 1 would indicate that the item is "not a reason" for participation, whereas a score of 7 indicates that the item is a "very important reason" for participation and scores in-between these extremes represented relative degrees of each reason.

The following are sample questions which sought responses to word stems such as; "To control my weight, To compete with others, To earn respect of peers, To improve my sporting performance, To earn respect of people in general, To socialize with other participants, To improve my health, To compete with myself, To become less anxious, To improve my self-esteem, To have something in common with other people, To add a sense of meaning to my life, To prolong my life and To become less depressed."

AIM

The aim of this cross-sectional comparative study was to investigate body mass index (BMI) within the WMG competitors in context with psychological motivations for competition. Whilst it has been identified that the socializing environment of sport was the most significant motivating factor in this cohort, it was hypothesized that masters athletes might be more preferentially motivated by associated variables, such as "to reduce my weight" as BMI increased. If motivations for competition were connected to participant BMI, this could result in more optimally targeted marketing and sport promotion strategies to increase participation in masters sport from those with the cardiovascular health risk factor, obesity (BMI>30kg/m^2).

METHODS

Approval for the study was granted by the university research ethics committee (ethics approval number n 2009 44) in accordance with the ethical standards of the Helsinki Declaration of 1975 (revised in 2008). The 2009 Sydney World Masters Games Organising Committee approved the project, stipulating the survey must only be provided in an online format. The survey was created using Limesurveytm, an open-source, web based application. This

was utilized to deliver the survey and investigate participants' demographics, medical health histories and injuries sustained in the preparation for the Sydney WMG. Electronic invitations were sent to masters games athletes who provided a valid email address upon registration. Filters were used in the participant questionnaires to abbreviate response times. After pilot testing by investigators, electronic invitations were sent to masters games athletes who provided a valid email address upon registration. The survey consisted of several sections. These sections featured questions related to the following areas: information for participants, a privacy statement, participant demographics, participant medical history (personal and family), past surgical procedures, prescribed medications, physiologic data, injuries sustained in the years of preparation for the tournament and psychological participation factors.

Using this survey, the BMI was derived using data gathered on a total of 6,071 masters athletes (51.9% male, 48.1% female) aged 25 to 91 years (mean=51.5, SD±9.7), competing at the Sydney World Masters Games (2009). A total of 4963 of these masters athletes (51.4% male, 48.6% female) aged 25 to 91 years (mean=51.1, SD±9.6) also completed the 56 item sports participation survey using a 7-point Likert response (1 - not important to 7 - very important). Questions focused on factors thought to promote participation, such as weight control, living longer, improving mental health (self-esteem, mood states), improving physical health and factors related to the athlete's competitive perspective.

Analysis of the data was completed using SPSS (Ver. 20.0.0). Bootstrapping, using a Mersenne Twister (Matsumoto, & Nishimura, 1998) for random number generation based on linear recurrence, was used to derive robust estimates of standard errors and confidence intervals of mean values. Bootstrapping was conducted based on 1,000 bootstrap samples. This was used to test the experimental hypotheses and determine whether particular psychological variables adequately described motivations across different BMI classifications.

RESULTS

A total of 46 underweight (17.4% male, 82.6% female), 2417 normal weight classification (43.3% male, 56.7% female), 1858 overweight (61.2% male, 38.8% female) and 642 obese (56.2% male, 43.8% female) masters athletes completed the 56 item sports participation survey, in addition to providing the height and weight data necessary for calculating BMI. Due to the lower number of underweight individuals, less inference was drawn from analysis of their sports participation survey scores.

There was significant variation in terms of motivating factors for the different BMI classifications, using Pearson's chi square. For obese masters athletes, the highest motivating factors were, "to socialise with other participants" (means score 5.92/7), "to compete with others" (mean score 5.34/7) and "to improve health" (mean score 5.20/7). The results of applying bootstrapping indicated that these motivating factors differed across BMI types. For the variable "to socialise with other participants", the 95% confidence interval of the mean for obese WMG athletes (5.82-6.05), was higher and did not overlap with those for overweight (5.67-5.80) or normal (5.57-5.70) classification masters athletes. This indicated that obese athletes were more likely to be highly motivated to compete in the WMG in order to socialise with other athletes than overweight or normal classification athletes.

The variable "to improve my health" also differed across BMI classification, with a lower 95% confidence interval range for the mean of obese WMG athletes (5.07-5.35), than for overweight (5.49-5.64) or normal (5.57-5.71) classification masters athletes. This indicated that improving health was less of a motivating factor for competition for obese than overweight or normal BMI classification athletes.

While 95% confidence interval ranges for the variable "to compete with others" trended upwards with BMI for normal (5.06-5.20), overweight (5.17-5.32) and obese (5.16-5.43) masters athletes, due to an overlap between intervals, it was considered inadvisable to conclude any substantive differences, based on BMI. For the variable "to reduce my weight", as expected, there was a clear trend, via Spearman Correlation of increasing importance as a factor with increasing BMI ($p=0.27$, $p<0.001$). Though coefficients of determination were small ($r2=0.052$), this pattern was re-iterated by the 95% confidence interval ranges for the mean for obese (3.46-3.77), overweight (3.37-3.55) and normal (2.51-2.65) masters athletes. These confidence interval ranges demonstrated a decreased focus on this factor for those with normal classification BMI.

DISCUSSION

There is the potential to promote masters sport as having many positive outcomes in terms of health related fitness, general motor fitness, injury reduction, sport specific fitness and mental health. The most important construct is to promote sport and physical recreation engagement and adherence to develop the attendant health related outcomes. However, the incentive structuring model to promote participation in sport and exercise should be based on promoting those psychological constructs that might be regarded as important to achieve these outcomes. In this research the factors identified as enhancing participation for obese individuals were "to socialise with other participants" (means score 5.92/7), "to compete with

others" (mean score 5.34/7) and "to improve health" (mean score 5.20/7). Whilst there was clear correlation between BMI and the factor "to reduce my weight", for obese individuals "to socialise with other participants" was still the highest ranked motivating factor. Given that this factor scored higher for obese individuals than for overweight or normal weight classified masters athletes, strategies to increase participation in masters sport for obese individuals should focus on socialising with other participants. Other factors such as weight loss, improving mental health and living longer were not identified as such important determinates of sports participation for obese individuals at the WMG level.

CONCLUSION

If designing programs to increase participation in masters' sports to accrue health related fitness in obese individuals, outcomes should be primarily based on those constructs such as the socializing environment of sport. Other factors such as weight control, mental health states and living longer were not identified as important determinants of participation and highlighting these as important might have minimal effects in increasing participation in masters' sports.

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ISTRAŽIVANJE PSIHOLOŠKIH FAKTORA MOTIVACIJE PRILIKOM TAKMIČENJA (MASTERS SPORTOVA) U KONTEKSTU INDEKSA TJELESNE MASE

Svjetske Masters igre (engl. WMG - World Masters Games: Svjetske Masters igre) su priznate od strane Međunarodnog olimpijskog komiteta, te predstavljaju najveće međunarodno sportsko takmičenje po pitanju broja učesnika. Cilj ovog istraživanja je ispitati indeks tjelesne mase (BMI) u kontekstu psihološke motivacije za takmičenje, što bi potencijalno moglo pomoći u promociji strategija za masters sportove. U kontekstu globalne epidemije pretilosti, ispitivanje ove nedovoljno istražene populacije bi moglo unaprijediti razumijevanje povezanosti između starenja, fizičke aktivnosti i pretilosti. Online anketom su ispitani učesnici WMG u Sydneyu. Analizirano je ukupno 4963 masters sportista (51,4% muškaraca) u dobi od 25 do 91 godinu (srednja vrijednost = 51,1 a SD±9,6). Psihološka pitanja su fokusirana na faktore za koje se smatra da promovišu učešće. Bootstrap metoda je dala grube procjene za standardne greške i interval pouzdanosti (CI) za srednje vrijednosti u iznosu 95%. Glavni faktori motivacije za pretile pojedince su bili "druženje sa drugim učesnicima" (srednja vrijednost 5,92/7), "takmičenje sa drugima" (srednja vrijednost 5,34/7) i "poboljšanje zdravstvenog stanja" (srednja vrijednost 5,20/7). Faktori prikazani pomoću bootstrap metode su bili različiti u BMI kategorijama. Faktor "druženje sa drugim učesnicima" je bio veći kod pretilih WMG sportista (CI 5,82-6,05) nego kod onih sa prekomjernom težinom (CI 5,67-5,80) ili masters sportista u kategoriji normalne težine (CI 5,57-5,70). Varijabla "poboljšanje vlastitog zdravstvenog stanja" se također razlikovala za BMI kategorije, te je bila niža za pretile (CI 5,07-5,35) u odnosu na sportiste sa prekomjernom težinom (CI 5,49-5,64) ili one koji spadaju u kategoriju normalne težine (CI 5,57-5,71). Pretili sportisti su bili više motivirani da se takmiče u svrhu druženja, a manje u svrhu samog takmičenja u odnosu na druge sportiste. Faktor "smanjenje tjelesne težine" je bio u korelaciji ($p=0,27$, $p<0,001$) sa BMI-jem, što je ponovno izraženo opsegom CI za pretile (3,46-3.77), sportiste sa prekomjernom težinom (3,37-3,55) i one koji spadaju u kategoriju normalne težine (2,51-2,65), prikazujući smanjen fokus na ovaj faktor kada su u pitanju sportisti sa normalnim BMI-jem. Uprkos korelaciji između BMI-ja i faktora "smanjenje tjelesne težine", za pretile osobe "druženje sa drugim učesnicima" je bio najviše rangiran faktor. Strategije u svrhu povećanja učešća pretilih osoba u masters sportovima bi se trebale fokusirati na druženje sa drugim učesnicima.

Ključne riječi: Queteletov indeks, psihologija sporta, učešće, masters sportovi.

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KINEMATIC AND KINETIC STUDIES OF 110 M HURDLE CLEARANCE TECHNIQUE

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ABSTRACT

The objective of this study was to establish and analyse those kinematic and kinetic parameters which to the largest extent generate efficient hurdle clearance technique as one of the most important factors of the hurdlers' performance in the 110m hurdle event. Test runs from starting blocks with the clearance of five hurdles, set in accordance with the competition rules, were carried out on a sample of four male hurdlers. Kinematic analysis was performed by the use of a 3 - D Ariel video system. The kinetic parameters of the take-off and landing for hurdle clearance were determined by means of Kistler force platforms. It was found that efficient hurdle clearance technique is generated by the following factors: the contact time of take-off, an optimal ratio of the braking phase to the propulsion phase of take-off, the ratio of the take-off point to landing relative to the hurdle, flight time, short braking phase in landing, a high position of the centre of gravity (CM) at landing and minimal reduction in the horizontal force of the CM at landing.

Keywords: Hurdle clearance technique, kinematic, kinetic, biomechanical model.

INTRODUCTION

According to some research carried out so far (Mero & Luhtanen 1986; La Fortune, 1988; McDonald & Dapena, 1991; Dapena, 1991; McLean, 1994; Kampmiller, Slamka & Vanderka, 1999, Iskra & Čoh, 2011), the hurdle clearance technique is one of the key elements defining the competition result. From the aspect of biomechanics, hurdles is a combination of cyclic sprinting and acyclic clearance of ten 1.067m hurdles. The hurdler must thus possess a high level of sprinting abilities, special flexibility at the hip joint, fast strength, and a high level of technical knowledge. During hurdle clearance, the loss of horizontal velocity must be as small as possible; however, this depends on numerous factors, especially those which define the take-off before hurdle clearance, the CG movement trajectory, and the landing after hurdle clearance. For efficient hurdle clearance, the take-off and landing points of hurdle clearance are important. The correct position of these two points is a prerequisite for an optimal CG flight trajectory and reflects in the flight time which must be as short as possible (Schluter, 1981; Dapena, 1991; Grimshaw, 1995). In addition to the correct position, the kinematic-kinetic structure of take-off and landing, which directly affects the velocity of hurdle clearance (La Fortune, 1988; McLean, 1994; Iskra, 1995), is also important. Therefore, the objective of the present study was to establish, by combining a 3 - D kinematic analysis and the method of measuring ground reaction forces, those most important parameters which generate the most efficient hurdle clearance technique.

METHODS

Biomechanical analysis was performed on a sample of four male athletes, whose average age was 23.5 + 5.06 years, with an average body height of 184.72 + 1.53 cm, and the average weight of 80.4 + 5.84 kg. The mean result in the 110m hurdles was 14.63 + 0.59 sec; the best result was 13.90 sec. The measurements were carried out on a track-and-field stadium with a tartan ground. According to the protocol, each athlete carried out three runs from the starting blocks with the clearance of five hurdles, set at standard race distances from the start. The kinematic and dynamic analyses of the technique were performed at the fourth hurdle. A 3 - D kinematic system ARIEL (Ariel Dynamics inc., USA) with two mutually synchronised digital cameras SONY DSR, operating at a frequency of 50 Hz and placed at an angle of 90° with respect to the object filmed, were

used to establish the kinematic parameters. The stride before hurdle clearance, hurdle clearance, and the stride after hurdle clearance were analysed. To measure the ground reaction forces during the hurdler's take-off and landing, force platforms KISTLER 9287, covered with a tartan layer and mounted at the same level as the track, were used. The vertical and horizontal ground reaction force data for the take-off and landing were collected at a frequency of 1000 Hz (Figure 1, 2). The quality of the technique used in clearing the fourth hurdle was measured with a set of infra-red photocells, placed at a distance of 5 m before and 5 m after the hurdle.

RESULTS AND DISCUSSION

The results in Table 1 show us the basic kinematic and kinetic characteristics of hurdle clearance. The hurdlers' speed in the hurdle clearance zone was 7.54 + 0.2 m.s-1.

During take-off, the horizontal velocity of the CG decreased in the braking phase by 0.41 m.s-1, while, at the same time, the vertical velocity in the propulsion phase increased to 2.53 m.s-1, which is the consequence of the requirement to raise the centre of gravity over the hurdle. The change in the relationship between the horizontal and vertical velocity is associated with the dynamic parameters of take-off. The braking phase lasts 59%, and the propulsion phase 41% of the total contact time.

The total time of the hurdlers' contact phase in front of the hurdle is 0.139 + 0.01 s. Similar values of take-off parameters were established in the study conducted by McLean (1994). In the braking phase, defined with the centre of gravity to foot distance of 0.50 + 0.08m, the hurdlers develop a peak horizontal force of - 1717 + 102 N and a peak vertical force of 3593 + 357 N, which represents 4.5 times their body weight.

The primary reason for the reduction in the velocity of the centre of gravity is thus the horizontal vector of the ground reaction force acting in the direction opposite to the direction of the hurdler's movement.

An efficient execution of take-off in front of the hurdle also has a direct effect on the efficient trajectory of the CG movement, which is expressed in the height and time of the hurdler's flight. In the athletes of our sample, the flight phase lasts 0.395 + 0.01 s and the fastest athlete (subject A) also has the shortest flight time 0.38 s. In addition to the magnitude and relationship of the forces which the hurdler develops during take-off, the foot to hurdle distance = 2.31 + 0.04 m is important for the definition of an efficient trajectory pertaining to the centre of gravity. This distance is individual and is associated with the morphological characteristics of the hurdler and the take-off angle = 71.6 + 1.37 °. In our hurdlers, the total length of the stride over one hurdle is 3.64 + 0.15 m. The landing occurs at 1.32 + 0.11 m from the hurdle. With respect to the results of the studies (La Fortune, 1988; McLean, 1994; Mc Farlene, 1994; Salo, Grimshaw, 1995; Kampmiller et al., 1999), the optimal ratio of the take-off to landing point is 65% : 35%. In our study we obtained almost the same result. The ratio of the take-off to landing is 63.7% : 36.3%. In subject B, who attained the worst result, this ratio is 62.0% : 38.0%.

For the fastest hurdler (subject A) we found that he has the largest foot to hurdle distance of 2.36 m (64.9 %), the shortest landing to hurdle distance of 1.28 m (35.1 %), the smallest take-off angle = 71.0 °, the consequence of which is a low position of the centre of gravity over the hurdle (0.33 m) and thus a short flight phase time of - 0.38 s .

For efficient hurdle clearance technique, the landing phase is equally important (Figure 2, Table 2). A poor technique in performing this component, of which a long contact time and a large percentage of braking time is characteristic, results in a large loss of the hurdler's horizontal velocity (La Fortune, 1988; Dapena, 1991; Salo & Grimshaw, 1997; Jarver, 1997). The landing technique differs significantly from the take-off technique. The braking phase lasts only 20% of the total contact time which amounts to 0.114 + 0.01 s.

This means that the athlete must place the foot as close as possible directly beneath the body's centre of gravity at landing. In top hurdlers, the braking phase lasts only 9 - 10% of the contact time (Schluter, 1981; McLean, 1994; Bowerman et al., 2009). The fastest hurdler in our experiment (subject A) also has the shortest contact time of 0.098 sec and uses only 17% of this time for braking. In the remaining propulsive part of the contact time, he increases the horizontal velocity of the centre of gravity by 0.32 m.s-1, which is the highest value among all athletes who participated in the experiment. The hurdler who attained the worst time in the hurdle clearance zone (subject B) has the longest contact time of 0.123 s and uses even 39% of this time for braking.

The peak horizontal force attained by the athletes in our sample in the braking phase is – 881 + 211.7 N, and the peak vertical ground reaction force is 2804 + 372.4 N. This data points to a large vertical impact force which the hurdlers can sustain by correctly placing the leg which must be fully extended.

In addition to the correct technique, the ability of the muscular system to resists fast stretching - stiffness is important in this case. Stiffness, as a neural mechanism of muscle action, depends, above all, on the preactivation of the muscles and action of the reflexes: myotatic reflex and Golgi tendon reflex (Gollhofer & Kyrolainen, 1991; Komi & Gollhofer, 1997; Enoka, 2003, Schache, et. al., 2014). With respect to the biomechanical characteristics

of landing, short-range elastic stiffness is characteristic, where an immediate mechanical response of the activated muscle to the eccentric contraction in the braking phase of landing is involved.

The efficiency criterion of the execution of this phase is the CG height in the braking phase that is 1.23 + 0.03 m. The CG height in the landing phase depends, of course, on the morphological characteristics of the hurdlers, especially their body height.

The best athlete (subject A) managed - despite the fact that he has the smallest body height in the experimental sample (BH = 183.4) - to maintain the highest position of the centre of gravity after landing and the largest horizontal velocity of 7.97 m.s-1. The landing phase is important, above all, from the aspect of the transition from hurdle clearance into sprinting to the next hurdle. In the athletes of our sample, the horizontal velocity in the braking phase of landing is 7.34 + 0.24 m.s-1, which indicates that, in the phase of hurdle clearance, the horizontal velocity decreased only by 0.27 m.s-1, from which we can conclude that the level of efficient hurdle clearance technique is high.

CONCLUSION

On the basis of the results obtained in the present biomechanical study, we can establish that the execution of take-off and landing defines the hurdle clearance efficiency degree, which is undoubtedly an important factor in determining the competition results of athletes in the 110m hurdles event. The time relationship between the braking and propulsion phases is completely different in take-off and landing. The function of take-off is to ensure a suitable transformation of the CG horizontal velocity into vertical velocity. The horizontal velocity decreases, and the vertical velocity increases due to the change in the direction of the CG movement. In the landing phase, which is one of the most important components of the technique, the contact time and its braking phase must be as short as possible in order to maintain the horizontal velocity of the CG while clearing the hurdle. The efficiency of hurdle clearance is also defined by the take-off angle, the correct ratio of the foot to hurdle distance in take-off and landing, flight time, and the height of the centre of gravity over the hurdle.

Table 1: Kinematic and kinetic parameters of the take – off phase (hurdle 5)

Parameters	Unit	Subject A	Subject B	Subject C	Subject D	Mean	SD
Rhythmic Units (Hurd le±5 m)	$m.s^{-1}$	7.87	7.35	7.51	7.40	7.54	0.23
Take – off (braking phase)							
Horizontal velocity of CM	$m.s^{-1}$	8.25	7.45	7.26	7.47	7.61	0.44
Vertical velocity of CM	$m.s^{-1}$	0.05	-0.02	-0.45	-0.61	-0.26	0.32
Velocity resultant of CM	$m.s^{-1}$	8.26	7.45	7.28	7.51	7.63	0.43
Braking time	s	0.79	0.78	0.89	0.83	0.82	0.05
Braking time %	%	59.8	58.2	60.5	58.1	59.15	1.19
Peak horizontal force	N	-1681	-1589	-1798	-1801	1717.25	102.14
Peak vertical force	N	3641	4056	3203	3475	3593.75	357.16
Take – off (propulsion phase)							
Horizontal velocity of CM	$m.s^{-1}$	7.88	6.88	6.64	7.38	7.20	0.55
Vertical velocity of CM	$m.s^{-1}$	2.26	2.14	2.41	2.26	2.27	0.11
Velocity resultant of CM	$m.s^{-1}$	8.20	7.20	7.06	7.72	7.55	0.52
Height of CM	m	1.21	1.20	1.21	1.19	1.20	0.01
Foot to hurdle distance	m	2.36	2.27	2.32	2.27	2.31	0.04
Contact time	s	0.132	0.134	0.147	0.143	0.139	0.01
Propulsion time	s	0.53	0.56	0.58	0.60	0.57	0.03
Propulsion time %	%	40.2	41.8	39.5	41.9	40.85	1.19

Table 2: Kinematic and kinetic parameters of the take – off phase (hurdle 5)

Landing (braking phase)	**Unit**	**Subject A**	**Subject B**	**Subject C**	**Subject D**	**Mean**	**SD**
Horizontal velocity of CM	$m.s^{-1}$	7.65	7.21	7.10	7.39	7.34	0.24
Vertical velocity of CM	$m.s^{-1}$	-1.72	-1.81	-1.73	-1.53	-1.70	0.12
Velocity resultant of CM	$m.s^{-1}$	7.85	7.44	7.31	7.56	7.54	0.23
Foot to hurdle distance	m	1.28	1.39	1.19	1.42	1.32	0.11
Braking time	s	0.17	0.48	0.14	0.14	0.23	0.17
Braking time %	%	17.4	39.1	11.6	12.3	20.10	12.93
Peak horizontal force	N	-678	-1179	- 824	-8.45	-881.50	211.78
Peak vertical force	N	2867	3304	2477	2569	2804.25	372.43
Landing (propulsion phase)							
Horizontal velocity of CM	$m.s^{-1}$	7.97	7.32	7.39	7.59	7.57	0.29
Vertical velocity of CM	$m.s^{-1}$	-1.31	-0.51	-0.77	-0.74	-0.83	0.34
Velocity resultant of CM	$m.s^{-1}$	8.09	7.34	7.39	7.59	7.60	0.34
Contact time	s	0.098	0.123	0.121	0.114	0.114	0.01
Propulsion time	s	0.081	0.075	0.107	0.100	0.091	0.02
Propulsion time %	%	82.6	60.9	88.4	87.7	79.90	12.93

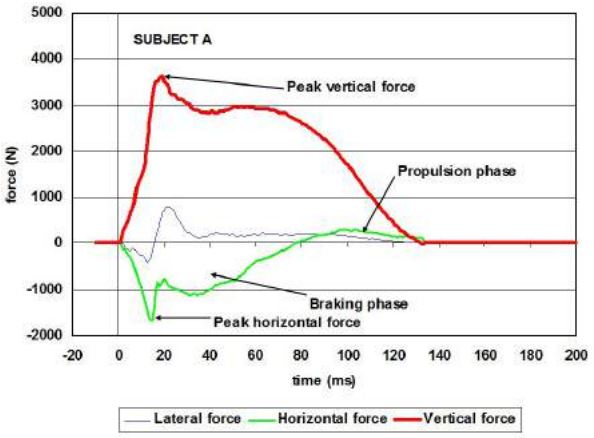

Figure 1: Force diagram of the take-off phase - hurdle 5

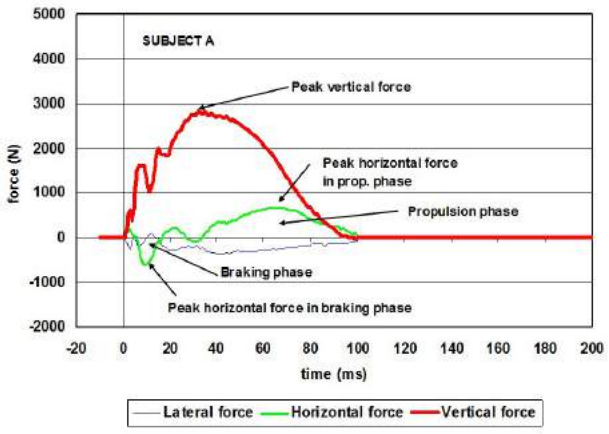

Figure 2: Force diagram of the landing phase - hurdle 5

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KINEMATIČKE I KINETIČKE STUDIJE TEHNIKE PRELAZA PREKO PREPONA U UTRCI 110 M SA PREPONAMA

Cilj ovog istraživanja je utvrđivanje i analiza onih kinematičkih i kinetičkih parametara koji najviše generišu efikasnu tehniku prelaza preko prepona kao jedan od najvažnijih faktora izvedbe atletičara u utrci 110 m sa preponama. Ispitivanje tehnike počevši od pozicije na startnim blokovima uz prelaz preko pet prepreka, postavljenih u skladu sa pravilima takmičenja, je izvršeno na uzorku od četiri atletičara. Kinematička analiza je izvršena korištenjem 3D Ariel video sistema. Kinetički parametri odraza i doskoka prilikom prelaza preko prepona su utvrđeni korištenjem Kistler platformi za mjerenje sile reakcije podloge. Otkrili smo da se efikasna tehnika prelaza preko prepona generiše sljedećim faktorima: kontaktno vrijeme odraza, optimalni odnos faze kočenja i propulzije prilikom odraza, odnos mjesta odraza i doskoka u odnosu na prepreku, vrijeme leta, kratka faza kočenja prilikom doskoka, visoko težište (CM) prilikom doskoka, te minimalno smanjenje horizontalne sile težišta prilikom doskoka.

Ključne riječi: Tehnika prelaza preko prepona, kinematički, kinetički, biomehanički model.

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THE FIGHTERS' GASTRIC REACTION AT DIFFERENT STAGES OF ONTOGENESIS UNDER COMPETITIVE PRESSURE

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ABSTRACT

This paper presents the results of a study on the reaction of the precise digestive glands in competitive pressures at different stages of ontogenesis. The article discusses an adaptation of the gastrointestinal glands of athletes in the fight against the competitive load of the age-dynamic. The results of the study are complementary to those in the field of sports and sports medicine, and indicate that they can be used by coaches and athletes to plan training sessions, competitive loads and recovery processes.

Keywords: Athletes are wrestlers, sports and sportive ontogenesis, gastric precise, competitive activity.

INTRODUCTION

Today's sport is characterized by an ever-increasing amount and intensity of training loads, which are sometimes on the verge of the athlete's body functional capabilities (Bykov, 2015; Erlich&Isayev, 2013). The need to identify the functioning of the organism at different stages of sports ontogenesis is a priority, not only for the development of an adequate number of sports teachers, but also for the preservation and improvement of health.

Therefore, an important part of the athletes' training process is a full recovery of the reduced health resulting from the mobilization of morphofunctional reserves (Koryagina&Roguleva, 2013; Landor, Vider&Lepik, 2006; Nicholas, 2003; Raja, Mills, Palmer& Fournier, 2007). In order to be successful, it is necessary to identify joint priority areas for interdisciplinary research in which teachers, psychologists, age physiologists, sociologists, etc. will be included in joint work. In particular, one of the least studied areas of the age of ontogenesis is the age of sports, which studies the influence of different sporting activities on the role of digestive glands in young athletes. And it is the digestive system which has a primary role to play in the recovery of both the energy and plastic costs of the athlete's body in the process of adjusting to muscle loads (Trohimchuk, 1999; Gryaznyh, 2011; Korot'ko, 2011; Kuznetsov, Smelysheva&Sidorov, 2014; Smelysheva, Sidorov, Vasiliev&Kiseleva, 2014).

Solving problems related to the study of the digestive glands' functional activity will not only influence the process of adapting the organism to regular muscle loads, but also develop the correct diet and workout mode (Dzgoeva, 2013; Hackney, McMurray, Judelsonand Harrell, 2003). In other words, the more adapted the system to the stress factor in the form of muscle load, the smaller the changes are observed in its operations. In particular, the effects of stress on the functional state of the gastrointestinal tract and the training activities' incorrigibleness effect on stomach secretion and some endocrine shifts in stress are analysed in the work of Smelysheva L., Jacob C., Carlsson, F. The work of the local writers shows that, as a result of high propulsion, the secretory function of the gastric gland is a two-way

version. The first option - hyperthyroidism secretory functions of the gastric gland - was found in athletes performing long work on endurance (cyclists, skiers, captured-stayers): its age, origins and mechanisms have been identified. The second variation in the secretory function of the gastric gland - hypothyroidism - has been detected in athletes engaged in speed-and-power sports (sports wrestling). However, research on the nature of hypothyroidism and the causes of its occurrence is insufficient (Panov, 2012).

It seems to us that the wrestlers' reaction of the gastric glands' secretory elements is the result of a long-term adaptation to the complex of the specific training factors that affect their organisms regularly. The essence of these is the existence of a huge amount of attack or defensive actions because of the constantly changing conditions of struggle and change. As a result, the training is done with constant changes in its power and energy costs. They can be very small when you have to keep some poses, or very large, when you are performing a pull and asphyxiating technique. Most of the wrestler's performance predominates, but there is also frequent static stress in the presence of pain sensations. All these factors appear to play an important role in the development of dominating in the gastric gland.
The purpose of this study was to examine the reaction of the precise digestive glands in a competitive load situation at different stages of ontogenesis.

MATERIALS AND METHODS

Our study on the regulation of digestive glands in athletes engaged in sporting wrestling at various stages of ontogenesis has been conducted for 25 years. This time line was conditionally divided into two periods. The first period from 7 to 25 years - the term "sports ontogenesis" - overlaps with the period of ontogenesis and takes place in the context of training and competitive loads. The second period from 25 to 32 years, the term "post sportive ontogenesis", coincides with the completion of the sports career and the departure from sport. During this period, there is a sharp decline in training and competitive loads, which may lead to negative changes in the organisms of the ex-athletes. In our view, this time line in the life of former athletes can be classified as a critical period and therefore studying the functioning of the body systems in sportive ontogenesis is one of the most important tasks of the age sports gastroenteritis.

According to the terms of the study, we identified a sample of athletes involved in the struggle - 173 fighters between the ages of 7 and 32. In accordance with the provisions of age, three groups of athletes in the period of the second childhood, two groups of athletes in adolescence, two groups of athletes in the youth stage and two groups of mature athletes were formed.
The study took place within the requirements of the ethical committee, i.e. all the subjects participated in the study with the written voluntary agreement, and with the minors having been officially authorized by the legal representatives. All of the subjects were required to be observed at a medical and physical medicine clinic, where a complete medical examination was conducted every year.

In order to study the functional state of the gastric gland, we used the method of factional gastral'nogo sensing as the most appropriate physiological method of gastric secretory function research. Sensing took place in peace and immediately after the load in competitive conditions.

The stimulation of digestive glands was influenced with cabbage juice in the amount of 200 ml (10% tea), which is an effective stimulant to the neurohumoral phase of production and is similar to food products.

In all the factions of the gastric glands, we took into account the volume (ml/h), pH, concentration and debit hour of hydrochloric acid (mg/h). In the gastric juice, we determined the concentration and gross output (debit hour) of the pepsinogen (mg/h) and the total proteolytic activity of the natural gastric juice (mg/h) in the original pH. The pH method (operating pH 340) and the classical Tetrovanija method were used to define the acid-forming function of the stomach.

In order to determine the indicators of basal area and stimulating secretion in the dynamics, we had to collect the contents separately by a 15-minute chunk in different receptacles within an hour.
As a competitive testing load, we simulated a one-day competition scheme in accordance with the rules of the sporting competition. All of our pledges spent 7 contractions on the wrestling carpet, which is about 40 minutes of pure peak competitive loads. The obtained experimental data were processed by the variation and correlation analysis using the Statistica 5.11 software package and Excel 2003. In order to assess the validity of the obtained results, the student-fisher test was used, with a probability of at least 95% ($R < 0.05$), that the differences between the indicators compared were considered reliable. The correlation coefficient (R) figured to identify the overcrowding and direction of the relationship between the values studied.

RESULTS AND DISCUSSION

In our study, all the measures of the gastric secretion are presented in terms of a kilogram of the athletes' body mass, i.e. relative units. In our view, this recalculation, firstly, provides more specific information for athletes who are involved in sports where the competition rules are divided into weights. In particular, during a competitive

day, our pledges lost a weight of 500 g (children and teenagers) to 1.5 kg (young men and adults), which in our opinion could not have been without prejudice to the reactions of the digestive conveyor. And secondly, when comparing relative indicators, we believe that the value of the results should be increased.

Table 1 presents the results of the study on the wrestlers' gastric glands reaction following a competitive load in a comparative aspect with those of the gastric precise in the state of muscular peace. As the data presented in Table 1 show, we do not see a reliable change in the secretion of children in a second child. The exception is the children of 11-12 years, where in this age category, which is the beginning of adolescence, the first credible leap towards an increase in the basal area secretion is being considered.

The same trend in the response of the indicators is being observed in younger adolescents (13-14 years), with the addition of a credible increase already in stimulation.

Table 1: Gastric Precise of the wrestlers in the muscular and competitive pressures
Note: B-under conditions of basal area secretion; C-under conditions of stimulating secretion; P-the validity of the differences by T-student criterion.

The subjects' age, years	N Quantity	Conditions of the study	Gastric Precise					
			Amount of secretion ML/hour		Debit Hour HCL mg/h		Debit hour Pepsinogen mg/h	
			b.	c	b.	c	b.	c
7-8	14	Peace	1.13±0.12	1.80±0.18	1.28±0.10	2.91±0.25	0.90±0.09	1.27±0.09
7-8	14	Load	1.03±0.02	1.72±0.12	1.43±0.18	3.49±0.29	1.11±0.14	1.60±0.21
	Credibility		p>0.05	p>0.05	p>0.05	p<0.05	p>0.05	p>0.05
9-10	17	Peace	0.93±0.14	1.67±0.31	1.02±0.12	2.95±0.30	1.91±0.31	1.57±0.21
9-10	17	Load	0.94±0.05	1.60±0.15	1.36±0.18	3.40±0.52	1.65±0.18	1.42±0.11
	Credibility		p>0.05	p>0.05	p<0.05	p<0.05	p>0.05	p>0.05
11-12	16	Peace	0.84±0.12	1.42±0.20	1.10±0.12	2.76±0.30	1.70±0.15	1.30±0.12
11-12	16	Load	1.05±0.12	1.53±0.12	1.39±0.15	3.34±0.25	1.67±0.14	1.25±0.13
	Credibility		p<0.05	p>0.05	p<0.05	p>0.05	p>0.05	p>0.05
13-14	17	Peace	1.61±0.20	2.18±0.22	1.71±0.21	3.29±0.19	0.75±0.09	1.38 ±0.11
13-14	17	Load	0.99±0.05	1.39±0.11	1.38±0.12	2.69±0.18	1.20±0.11	1.80±0.12
	Credibility		p<0.001	p<0.01	p<0.05	p<0.05	p<0.01	p<0.01
15-16	16	Peace	1.50±0.11	1.52±0.13	2.05±0.59	3.53±0.32	0.41±0.03	0.62±0.03
15-16	16	Load	1.43±0.14	1.50±0.11	1.69±0.13	2.94±0.21	0.40±0.02	0.64±0.03
	Credibility		p>0.05	p>0.05	p<0.05	p<0.05	p>0.05	p>0.05
17-18	20	Peace	1.10±0.01	1.28±0.01	1.26±0.10	1.94±0.15	0.61±0.01	0.52±0.02
17-18	20	Load	1.17±0.06	1.45±0.10	1.27±0.09	1.88±0.12	0.95±0.05	0.79±0.04
	Credibility		p>0.05	p>0.05	p>0.05	p>0.05	p<0,01	p<0,01
19-21	28	Peace	1.12±0.01	1.11±0.01	0.87±0.08	0.49±0.02	1.40±0.06	0.58±0.04
19-21	28	Load	1.04±0.14	1.45±0.11	1.07±0.08	0.62±0.05	1.63±0.12	0.81±0.03
	Credibility		p>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p<0.05
22-25	27	Peace	1.09±0.08	1.34±0.02	1.17±0.07	0.55±0.06	1.47±0.09	0.57±0.04
22-25	27	Load	1.04±0.07	1.43±0.12	1.05±0.11	0.69±0.04	1.88±0.21	0.84±0.07
	Credibility		p>0.05	p>0.05	p>0.05	p>0.05	p<0.05	p<0.01
25-32	18	Peace	0.65±0.08	1.28±0.17	0.10±0.01	0.58±0.03	0.05±0.012	0.23±0.017
25-32	18	Load	0.62±0.03	1.04±0.12	0.24±0.01	0.42±0.03	0.23±0.01	0.26±0.02
	Credibility		p>0.05	p<0.05	p<0,01	p<0,01	p<0.001	p>0.05

The data we have received can be seen as an additional argument that confirms the basis of the theory pertaining to sensitive periods of the organism's development. In the other age groups of sports ontogenesis, changes in both the basal area and the stimulating volume of the secretion are irrelevant. And only for athletes in the age category of the sportive ontogenesis period, we note a credible leap towards a reduction in the incentive secretion.

In analysing the acid-forming function of the digestive glands, we note that there is a similar trend when it comes to the changes in the indicators, but with manifestations of its characteristics. In the reaction of the HCL structures, a reliable increase in the numbers is occurring in a more extended age range: for 9-12 years old children, junior and senior teens, 13-15 years old, and ex-athletes.

The basal area secretion of hydrochloric acid is reliably reduced in adolescents and children, while the secretion is steadily increasing ($p< 0.05$-0.01) in former athletes. In an incentive secretion, the function of digestive iron has a sharp and reliable fall for the wrestlers who have completed their sporting activities ($p< 0.01$). In the remaining age groups, the Precise HCl is marked by relative stability. As we consider the fermentation of the digestive tract, there has been a shift in the rates of young adolescents, young boys, active and ex-athletes. Against the backdrop of a credible decline in the basal area and stimulating secretion of HCL, the athletes of 13-14 years of age have a compensatory effect, expressed in a reliable increase in basal area and stimulating secretion debit hours of pepsinogen. In the 17-18 age category there is a noticeable increase ($p < 0.01$) and basal area and stimulating precise pepsinogen.

In the light of the steady results pertaining to the hydrochloric acid secretion, senior youth and adult athletes are experiencing a reliable increase in secretion for the basal area and incentive debit hours pepsinogen. In our view, this is a positive fact, manifested in the correction role of the pressure exhibited during the competition activity in the iron precise.

In the case of former athletes, the pepsinogen in the basal area secretion is the process of absorption in the stimulating secretion of pepsinogen. Considering the dynamics of the total proteolytic activity (SPA) as one of the most important integral indicators of the actual performance of the digestive pipeline [9], we come to the following conclusions (figure).

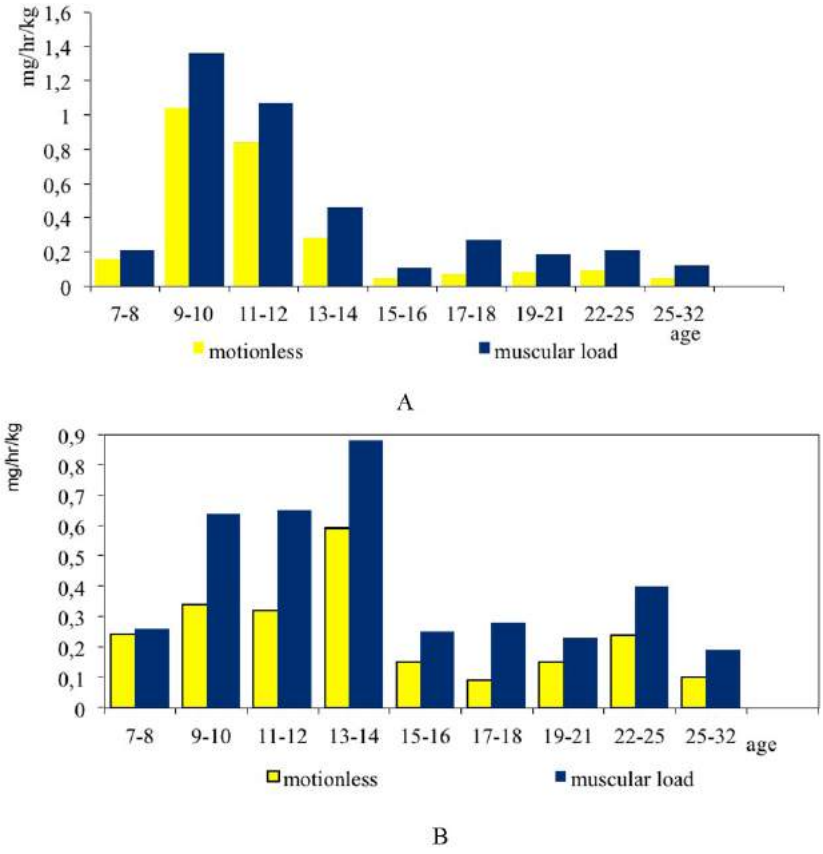

Figure 1: Basal area and stimulating (b) proteolysis among wrestlers in the face of muscle peace and competitive pressure

Competitive pressures have a reliable increase in the rheumatic valve defects of all age groups of pledges, except for the children 7-8 years old. In almost all age categories, the total proteolytic activity is 1.5-2 times higher than that of the athlete's muscle peace. The most pronounced leap ($p < 0.001$) is observed in the basal area and stimulating proteolysis of young men 17-18 years old and basal area proteolysis of active athletes, which exceeds the three-time span for muscle-peace. In our view, such results may indicate a fairly significant secretion of the digestive glands for highly skilled athletes (candidates in the Sports Masters) who have had a long history of training and competition. The analysis of the results obtained in the study of the gastric reaction to the load of a competitive nature is presented in values. However, the reflection of individual reactions in the precise of the wrestlers' gastric juice various components in the sports and sportive ontogenesis in response to this load is also of scientific interest. Table 2 shows the results of the study, depending on the direction of the A.A progression. Pleshakova examines five variations of gastric reactions to different effects (metered bike-ergo-meter and training loads, emotional effects, termination): the 1st option is the rise of the basal area and stimulating secretion; 2nd- the rise of the basal area and recession of the incentive secretion; 3rd- the rise of the stimulus and the recession of the basal area secretion; 4th- there is no change in the basal area and stimulating secretion; 5th- recession of basal area and stimulating secretion.

Table 2: Individual reactions of the wrestlers' gastric glands in response to a competitive load

Pledge groups	Gastric reaction options																			
	On indicators of JSD					On indicators of acid					On indicators of fermentation					On indicators of proteolysis				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
7-8 years old, n = 14	1	2	2	4	5	3	4		5	2	8	2	2		2	7	1	1	3	
9-10 years old, n = 17		3	3	7	4	13			2	2	1	3	3	6	4	12	1	1	3	
11-12 years old, n = 16	8	2	2		4	10	3		3			3	3	7	3	16				
13-14 years old, n = 17		1	1		15			3	2	12	14	1	2			17				
15-16 years old, n = 16		3	2	4	7		1	3	4	8				4	12	16				
17-18 years old, n = 20	2			18					16	4	20					20				
19-21 years old, n = 28		2	14	12		12	3	1	12		10		5	13		28				
22-25 years old, n = 27			18	9				7	20		19			8		27				
25-32 years old, n = 18			8	10		18					10			8		18				

As we analyse table 2, we do not see a strong dominance in individual reactions to the competitive load of the secretion volume, debit hours HCL and debit hours pepsinogen in the age categories of children in the period of the second childhood and adolescents. And it is only by indicator of the total proteolytic activity that there is a demonstration of stability in the response options. The increase in the basal area and stimulating secretion (compliance with the first option), is noted in 68 out of 80 cases.

For boys and active athletes with longer career experience, the reaction of the gastric gland to a competitive load is a measure of consistency. It is dominated by the 4th response (no change in basal area and stimulating precise) - 49 out of 75 people, and acid - 48 out of 75 people. The fermentation function is dominated by the 1streaction (increasing basal area and stimulating precise) -49 out of 75 people.

In former athletes, the reaction of the gastric gland to the competitive load is also consistent in its manifestation: dominated by the 4th option; on the acid and fermentation -1. According to proteolysis indicators, all the testers have found the dominant coordinated reaction of the gastric gland to the competitive load is the 1st reaction, which is in the increase of basal area and stimulating precise. The children of 11-12 years old, adolescents 13-

16 years old, young men 17-21 years old, active athletes of 22-25 years of age and ex-athletes of 25-32 years of age - all reacted 100% to the 1 - zero response option. The resulting picture of such a uniform and consistent reaction of the gastric gland to the load of a competitive nature once again underscores the direct dependence of the digestive pipeline reaction rates on the level of training and length of service.

CONCLUSION

In fact, we have basically found, in our studies, a uniform and coordinated response of production gastric glands to the load of competitive pressures in the sports and sportive ontogenesis. This response to the reaction of the digestive glands in the wrestling athletes has shown a reliable increase in the proteolysis in almost all the age groups of the wrestling athletes. The only exceptions are the children 7-8 and 9-10 years old, who have come to fight and have a small training experience. This time line can be seen as a stage of urgent or imperfect adaptation in which a set of functional changes in the system are only beginning to develop.

Further functional changes in the system are gradually taking place under the influence of the training and competitive loads on the basis of urgent adaptation, as has been evident in our research into the reaction of the gastric glands of highly skilled wrestling athletes. In other words, a phase of long-term adaptation of the organism begins. At this stage, as a result of constant systematic training and competition, the organism is moving to a new stage in its development and is beginning to adapt to the current factor.

Summarizing the results, I would like to emphasize that all of the above manifestations are the product of sustained adaptive shifts, which have the effect of propulsion on the functional state of the gastric secretion. It is through the mobilization of the morphofunctional reserves and its adaptation to external factors, namely the effects of additional loads. It is believed that raising the level of proteolysis in the basal area and stimulating secretion from the wrestlers is the "measure of adaptation" of the digestive glands to the effects of competitive loads.

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ŽELUČANA REAKCIJA HRVAČA U RAZLIČITIM FAZAMA ONTOGENEZE PRI KONKURENTSKOM PRITISKU

U radu su predstavljeni rezultati istraživanja reakcije preciznih probavnih žljezdi pri konkurentskom pritisku u različitim fazama ontogeneze. Rad razmatra prilagođavanje gastrointestinalnih žljezdi sportista u borbi protiv konkurentskog opterećenja dinamike dobi. Rezultati istraživanja su komplementarni sa onim dobivenim na polju sporta i sportske medicine, te ih mogu koristiti treneri i sportisti kako bi planirali trening, konkurentsko opterećenje i proces oporavka.

Ključne riječi: Sportisti su hrvači, sport i sportska ontogeneza, pravilan rad želuca, takmičarska aktivnost.

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KINEMATIC-GONIOMETRIC PARAMETERS OF A LEG KICK ASHI MAWASHI GERI

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ABSTRACT

If it is done quickly and correctly over the opponent, the leg technique Ashi Mawashi Geri is very profitable. The purpose of this study is to analyse and determine the time-speed and kinematic-goniometric parameters of six top athletes under the following conditions: when the karate athlete performs the strike in the attack and when the karate athlete performs the strike in the situation of Diae (when attacked by the opponent). The performance of each stroke, individually for each respondents, is recorded with three digital cameras with a frequency of 60 Hz. Ariel Performance Analysis System (APAS) was used to analyse the strike. When performing Ashi Mawashi Geri in the first variant, an average value of the foot speed of 12.58 m / s was achieved, while the time it takes to move from the starting position to the maximum foot speed is 0.43 seconds. The time taken to strike from the starting position until the end of the foot movement is 0.54 seconds. The knee angle, at the maximum foot speed, reaches an average value of 82.17 degrees. In the event of an Ashi Mawashi Geri in a Diae situation, the maximum foot speed is 12.82 m / s, the time taken to strike from the starting position to reach the maximum foot speed is 0.41 s, while the total time required to perform the whole movement is 0.57 seconds. The value of the knee angle during the stroke of the second variant is 97.50 degrees. The values of all time parameters in the performance of the foot strike Ashi Mawashi Geri in attack and Diae are with relatively same values, therefore no statistically significant difference ($p < 0.05$) was recorded in any of these variables, because the movement is the result of automatism with a perfect motor stereotype.

Keywords: Ashi Mawashi Geri, kinematics, velocity, angle, time.

INTRODUCTION

Leg kicks in karate competitions have a great application. Many competitions are solved precisely by these strikes (knowing the data from the international judicial karate rulebook that the kick in the head carries three points, and in the body two points), which means they give an advantage at the total score for deciding the winner in the combat. The main purpose of this strike is the fictive destruction of the opponent in the sport combat. The timeliness of performing direct kicks in karate sports is essential to their effectiveness, because they are explosive segmental movements of ballistic character (Chananie, 1999). They are performed at high speeds and in a short period of time, whereby the visual-motor response is of primary importance for the defence against them. The latent time of the visual-motor reaction (the time it takes from receiving the information through the eyes to the muscle response of the adequate muscle) is a time that defines the timeliness. The factor of surprise is huge in performing some of the leg techniques, in the condition of the maximum rapidly and explosively performed technique. The stroke Mawashi Geri can be performed with both legs, i.e. left or right (Gabriela 2008). This stroke is characterized by specific kinematic-goniometric parameters, which can be determined by a video

and similar methods. The kinematic-goniometric parameters of leg impacts in karate sports are relevant to the kinesiology researchers, and by improving the technology of their tracking, more relevant data is obtained. The success of the impact requires not only high performance in motor motion, but also a high level of perception (Shuji, 2002). The analysis of the leg-to-head and the leg-to-body kick Ashi Mawashi Geri is of a great importance for successful performance, learning and improvement of the same, and in order to achieve higher sports results. The main purpose of the research is to determine the time-speed and kinematic-goniometric parameters.

METHODS

The sample of respondents includes six top athletes in karate sports, who are seniors with longer training and competition time, which is a sufficient indication that they have a motorized stereotype in the performance of the strike.

During the research, the respondents are barefoot in pants so that the joint points of the levers model can be better registered. In this study, the impact of Ashi Mawashi Geri is analysed in two variants of performance; 1. when the karate athlete performs the strike in attack and 2. when the karate athlete performs the strike in a situation of Diae (attacked by an opponent). To analyse the strike in this study, the entire karate movement in all three spaces has been taken into account. The strike is derived from the initial position (Fudo Daci). The body is upright and the weight is evenly placed on both feet; the torso is facing forward and the projection of the body centre is projected in the middle between the two feet, making the angle of confidence even greater. The hands are folded in the elbow joint and placed in front of the torso in the battle guard. The sample of variables consists of: maximum foot speed, the time it takes to move from the starting position to the maximum foot speed, total time from the starting position to the kick, knee angle at maximum foot speed, knee angle during the kick, hip angle at maximum foot speed, hip angle during the kick. All of the above variables are analysed in both variants of impact. Ariel Performance Analysis System was used for this research and for analysing the leg kick Ashi Mawashi Geri. The performance of each leg kick, individually for each subject, is recorded with three digital cameras (60fps - images per second). Then, those recordings are entered into the computer (Kinematics Analysis System - APAS). In this way, all the modules of the system (APAS) are analysed and processed, and then precise information for the entire movement is obtained.

RESULTS AND DISCUSSION

In Table 1, the kinematic-goniometric parameters of the leg kick Ashi Mawashi Geri are shown in the two variants of the respondents. When performing Ashi Mawashi Geri in the first variant, a maximum foot speed of 15.95 m / s is evidenced, or a mean value of 12.58 m / s is recorded, while the minimum values are 10.14 m / s. In a survey of the identical strike conducted by Y-H Nien and co-workers (2007) with six top athletes from Taiwan's National Taekwondo team, they found that the maximum foot speed reaches 17 m / s. Comparing these results, with the results obtained from this research, it can be concluded that better results have been achieved. These are the expected results if we take into account the manner of conducting the fight in Taekwondo. While talking about an identical strike, it must be noted that the emphasis on practicing the fight in Taekwondo is with a round knee strike.

Table 1: Ashi Mawashi Geri kinematic-goniometric parameters

Variables	Attack					Diae			
	N	Min	Max	Mean	Std. D.	Min	Max	Mean	Std. D
MAX. F. S. (m.s-1)	6	10.14	15.95	12.58	2.10	8.78	17.59	12.82	3.78
TIME. MAX. S. (sec)	6	.25	.62	.43	.13	.26	.57	.41	.10
TOTAL. TIME. (sec)	6	.40	.70	.54	.11	.36	.65	.57	.09
KNEE. ANG. DU. MAX. S (°)	6	34.00	105.00	82.17	25.79	72.00	116.00	97.50	15.21
KNEE.ANG.DU.ATT (°)	6	158.00	174.00	165.67	6.38	155.00	170.00	165.17	5.71
HIP. ANG. DU. MAX. S (°)	6	105.00	140.00	126.17	13.58	117.00	142.00	128.00	9.40
HIP.ANG.DU.ATT (°)	6	109.00	127.00	115.50	6.72	104.00	120.00	110.00	6.23

The time it takes to move from the starting position to reach the maximum foot speed goes from a minimum of 0.25 seconds to a maximum of 0.62 seconds with a mean value of 0.43 seconds. The time required to perform the stroke from the starting position until the end of the foot movement is in the range of 0.40 to 0.70 seconds, with a mean value of 0.54 seconds. The standard deviation for all time parameters ranges within one standard deviation, indicating that the results are moving around the centre or around zero, and it can be concluded that it is a relatively homogeneous group of respondents. The research of Wąsik, J. (2010), which he performed on a 17-year-old karate athlete, set the time for strike performance of 0.75 seconds. He points out that the round stroke (Ashi Mawashi Geri) is the most commonly used strike in the combat. These results are relatively weaker compared to the results obtained in this research, but given that the research is conducted with a karate junior, they are also expected.

The goniometric parameters such as the knee angle and the maximum foot speed reach from a minimum of 34 to a maximum of 105 degrees, with a mean value of 82.17 degrees. Given the different physical structure and belonging to a different weight category of karate athlete, the different performance of the strike technique is also reflected upon. Because of this data, larger deviations in the standard deviation are visible, which is 25.79 degrees. A research carried out by Wąsik, J. (2010) obtained a knee-angle result of 54 degrees, with its results being in the average values of these results. The knee angle in the phase of the maximum reached path, i.e. when the foot movement is complete, has relatively similar values in all respondents, with a minimum angle of 158 and a maximum angle of 174 degrees. The medium value of the knee angle at impact is 165.66 degrees.

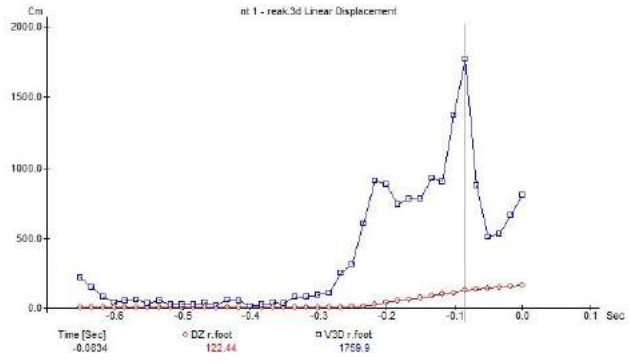

Figure 1: Graphic display of the maximum strike speed Ashi Mawashi Geri (for one respondent)

Standard deviation moves in one standard deviation indicating the fact that the results are around zero. The hip angle at the maximum foot speed is at least 105 degrees, while the maximum values are 140 degrees. The mean value of the hip angle is 126.17 degrees. Standard deviation amounts to 13.58 degrees, which is relatively lower in relation to the knee angle at maximum foot speed, where the angle of the hip in the foot stroke ranges from 109-127 degrees with a mean value of 115.5 degrees. Standard deviation is 6.72 degrees and moves within one deviation, i.e. around zero. While performing the leg kick Ashi Mawashi Geri in the Diae situation, the maximum foot speed (table 1) goes from a minimum of 8.78 m / s to a maximum of 17.59 m / s, with a speed mean value of 12.82 m / s. Standard deviation is 3.78 m / s and moves within one standard deviation. In a survey by YH Nien et al. (2007), which he conducted with six top athletes from Taiwan's National Taekwondo team, they found that the maximum foot speed required in Diae, reaches 16 m / s, which, compared to this study, is slightly lower than the value.

The time it takes to perform a strike from the starting position and reach the maximum foot speed goes from a minimum of 0.26 seconds to a maximum of 0.57 seconds. The average time required to develop the maximum speed is 0.41 seconds. Standard deviation is 0.10 hundredths, indicating that all karate athletes are relatively homogeneous in achieving the maximum speed.

The total time required to perform the whole movement, from the starting position to the final position of the foot under Diae, goes from a minimum of 0.36 seconds to a maximum of 0.65 seconds. By analysing the obtained results, it can be said that leg kicks in the karate sport are very fast and performed in parts of a second. In order for karate athletes to achieve these time parameters, they should be well-prepared, both technically and physically. The mean value of the total strike is 0.57 hundredths. Standard deviation ranges within one standard deviation, amounting to 0.09 seconds, and indicating that all respondents are homogeneous in carrying out the strike in the case of Diae.

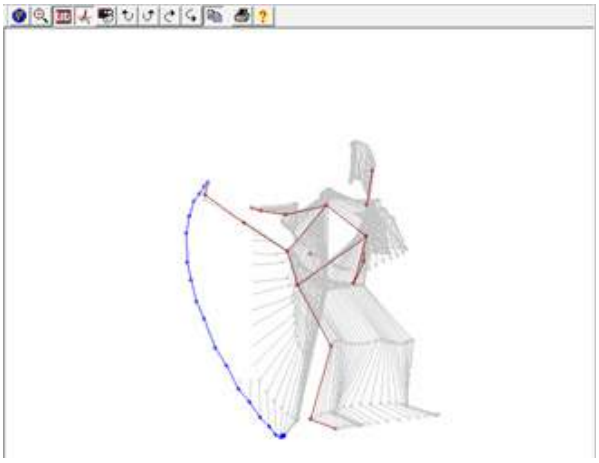

Figure 2: Contourogram trajectory of the foot (for one subject)

The knee angle at maximum foot speed is at least 72 degrees to a maximum of 116 degrees, with a mean value of 97.50 degrees.

Standard deviation is 15.21 degrees which departs from the frame of one standard deviation and shows that the knee angle at maximum speed is relatively different for different athletes, which is expected taking into consideration that karate athletes have different anthropometric characteristics. The knee angle results in foot strokes range from a minimum of 155 degrees to a maximum of 170 degrees. The mean value of the knee angle in all six karate athletes is 165.17 degrees. The value of the standard deviation is 5.71 degrees. The similarity of this angle comes due to the fact that all karate athletes tested in this research are top athletes and have perfected the performance of the strike Ashi Mawashi Geri. The hip angle at maximum foot speed is at least 117 degrees, with a maximum of 142 degrees (Table 1).

The mean value taken from the total number of karate athletes is 128 degrees. In a survey carried out by Alaa (2011), on the strike Mawashi Geri Cudan, he found that the speed of the strike increased with an increase in the hip angle and reached a maximum of 171 degrees. Standard deviation is within one standard deviation of 9.40 degrees.

The hip angle at a foot strike ranges from a minimum of 104 degrees to a maximum of 120 degrees, with a mean value of 110 degrees. And in this result, the standard deviation moves within one standard deviation around the centre and it is 6.23 degrees. Table no. 2 shows the results of the T-test for the variables showing the strike velocity and the achieved angles of the knee and the hip joints during the performance of both types of strike Ashi Mawashi Geri. The values of the arithmetic means in the time parameters for the execution of the leg kick Ashi Mawashi Geri in attack and Diae are of relatively same values, and therefore there is no statistically significant difference in any variables of this type.

Table 2: T-test between Ashi Mawashi Geri attack and Diae
1 – Ashi Mawashi Geri, attack / 2 - Ashi Mawashi Geri, Diae

	Var	N	Mean	St. dev	F	df	t	Sig.
MAX. F. S. (m.s-1)	1.00	6	12.58	2.10	2.79	10	-.139	.892
	2.00	6	12.82	3.78		7.82	-.139	.893
TIME. MAX. S. (sec)	1.00	6	.43	.13	.320	10	.276	.788
	2.00	6	.42	.10		9.62	.276	.789
TOTAL. TIME. (sec)	1.00	6	.54	.11	.558	10	.451	.662
	2.00	6	.52	.09		9.74	.451	.662
KNEE. ANG. DU. MAX. S (°)	1.00	6	82.17	25.79	1.227	10	-1.254	.238
	2.00	6	97.50	15.22		8.10	-1.254	.245
KNEE ANG. DU. ATT (°)	1.00	6	165.68	6.38	.186	10	.143	.889
	2.00	6	165.17	5.71		9.88	.143	.889
HIP. ANG. DU. MAX.S (°)	1.00	6	126.17	13.593	.668	10	-.272	.791
	2.00	6	128.00	9.40		8.10	-.272	.792
HIP ANG. DU. ATT.(°)	1.00	6	115.50	6.72	.008	10	1.471	.172
	2.00	6	110.00	6.23		9.94	1.471	.172

From this we can conclude that the already learned and automated movement, as a result of a large number of repetitions, in the karate athletes is performed at the same speed and time, regardless of the situation in which it is performed. The decision to strike is the crucial factor, while the subsequent movement is a result of automatism with a perfect motor stereotype.

Also, statistically significant differences haven't been noticed in the variables that define the goniometric parameters in the performance of the two variants of strike Ashi Mawashi Geri. In these variables, one can come to a similar conclusion that a movement, once learned and formed, is performed along the same trajectory and thus the same sequence of muscle activation is responsible for it. All this leads to occupying the same angles in the joints.

CONCLUSION

A sample of six respondents, top athletes from karate sport who are seniors, was used to realize the purpose of the research. The sample in this study was the strike Ashi Mawashi Geri in two variants of the performance, Ashi Mawashi Geri in attack and Ashi Mawashi Geri in Diae.

The strike Ashi Mawashi geri is carried out at a high speed and it is of a ballistic character, that is, a strike in which, after the decision to perform and start the movement, it is not possible to correct the movement trajectory. With long-term training and a large number of repetitions, it is the already learned and automated movement the karate athletes perform at a relatively same speed, regardless of the situation in which the strike is performed. The decision to perform the strike is a crucial factor for its effectiveness, in the conditions of a perfect motor stereotype and movement automatism. According to the set goal, statistically significant differences in the performance of the strike were not determined for all variables of the speed and goniometric parameters.

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KINEMATIČKI I GONIOMETARSKI PARAMETRI UDARCA NOGOM ASHI MAWASHI GERI

Ukoliko se izvrši brzo i ispravno, AshiMavashiGeri tehnika udarca nogom je jako korisna. Svrha ovog istraživanja je analiza i utvrđivanje parametara brzine i vremena, kao i kinematičkih i goniometarskih parametara šestorice vrhunskih sportista u uslovima kada karatista vrši udarac u napadu i kada karatista vrši udarac u Diae situaciji (kada ga protivnik napadne). Svaki udarac je pojedinačno zabilježen za svakog ispitanika uz pomoć tri digitalne kamere frekvencije 60 Hz. Ariel PerformanceAnalysis (APAS) sistem je korišten prilikom analize udarca. Prilikom izvođenja tehnike AshiMavashiGeri u prvoj verziji, prosječna vrijednost brzine stopala je bila 12,58 m/s, dok je vrijeme proteklo od zauzimanja početne pozicije to maksimalne brzine stopala iznosilo 0,43 sekunde. Vrijeme potrebno za udarac iz početne pozicije do završnog pokreta stopalom je iznosilo 0,54 sekunde. Ugao koljena tokom maksimalne brzine stopala je dostigao prosječnu vrijednost od 82,17 stepeni. U slučaju primjene tehnike AshiMavashiGeri prilikom Diae situacije, maksimalna brzina stopala je iznosila 12,82 m/s; vrijeme potrebno za udarac iz početne pozicije do dostizanja maksimalne brzine stopala je iznosilo 0,41 s, dok je ukupno vrijeme potrebno za izvođenje potpunog pokreta iznosilo 0,57 sekundi. Vrijednost ugla koljena tokom udarca u drugoj verziji je iznosila 97,50 stepeni. Vrijednosti svih parametara vremena u izvedbi udarca stopalom AshiMavashiGeri prilikom napada i Diae situacije su relativno iste, pa, prema tome, nije zabilježena statistički značajna razlika ($p < 0,05$) u bilo kojoj varijabli zato što je pokret rezultat automatizma sa savršenim motoričkih stereotipom.

Ključne riječi: AshiMavashiGeri, kinematika, brzina, ugao, vrijeme.

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MODELLING AND ASSESSING THE VISUAL SEARCH BEHAVIOUR OF PLAYERS USING A HUMAN-COMPUTER INTERACTION BASED SYSTEM

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ABSTRACT

The implementation of wireless electronic simulation signals, as an approach to the visual search behaviour recognition, is not a straightforward task. This paper discusses the process of modelling human interactions in a real game by wireless electronic visual stimuli, which could lead Human Computer Interaction (HCI) researchers in sports and education sciences to benefit from using electronic models and stimuli, as well as to measure features. Methodology standardization would allow for a comparison of results, reliability of findings and easier integration of the various behaviour recognition systems created. The aim of this paper is to present a leading validation experimental process for B-percept® behaviour modelling, decision-making and an assessing system, to provide directions on which the future research efforts, for modelling and assessing behaviour, using HCI should be focused on.

Keywords: Modelling, Nonverbal Behaviour, eight-corner game, B-percept.

INTRODUCTION

Movements give life and energy to speech. They sometimes provide thoughts and intentions in a truer manner than words (Darwin, 1877). Thus, movements, gestures and behaviours in sports activities and games had shown that, the use of body expressions and gestures for communication between competitors, provide additional information about the strategies and intentions (Barrier, 2011) (Vincent&Schulé, 2015).

In addition, the nonverbal behaviour gives supports for the verbal instructions or feedback made by the coach or a partner (Moreno, 1970; Parlebas, 1992) (Marie Level, 2010) (Vincent &Schulé, 2015). Thus, in sports and physical activities, gestures often carry an affective connotation: e.g., a participant performing an exercise and seeking feedback from the coach will look at him. If he smiles at him, the thumb of his finger raised upwards, he understands that he has realized the task and the coach is proud of his work.

Consequently, communication was principally classified by research into three categories: the "expressive movements" for facial expressions (Jayagopi, Hung, Yeo, &Gatica-Perez, 2009), the "manipulative gestures" for gestures, and stances (Edelmann& Hampson, 1979), and the "conversational gestures"(Krauss, Chen, & Chawla, 1996) (Hall, Coats, &LeBeau, 2005). Furthermore, Parlebas (1999) specified, in accordance with (Mead, 1934) (Goffman, 1959) (Thornton &Nardi, 1975), that, while practicing a game (i.e. sports games or traditional social game), we continually play roles and

manage the impressions of ourselves that we give off. So, some behaviours could be mainly used to transfer misleading or allusive decisions to overtake opponents. Methods used in behavioural science to interpret human movements and gestures have basically evolved in the last decades, due to the increasing availability of quantitative data.

Researchers interested in collecting behavioural data to investigate the decision processes and communication strategies in human society, have taken benefit from new tools and methods for coding behaviours (Koch &Zumbach, 2002), (Shteynberg et al., 2014) (Friard&Gamba, 2016). Thus, photos, video cameras and audio recorders facilitated to store a large amount of data in psychology, social psychology, anthropology, medicine, neuroscience, robotics and cognitive science (Vinciarelli, Salamin, &Pantic, 2009) (Jayagopi et al., 2009) (Barrier, 2011) (Cristani, 2013). Furthermore, electronic devices and computer-aided programs gave the possible chance for innovative research in modelling nonverbal human behaviour especially in the field of videogames design (Bailenson& Yee, 2005) (Leite, Castellano, Pereira, Martinho, &Paiva, 2012) e.g., in "Nintendo Wii" and "Microsoft Kinect".

Nevertheless, the review of the state of the art (Parlebas, 1992) (Parlebas, 2005), coding and simulating behaviour in pedagogy, physical education and rehabilitation (Caramiaux et al., 2014) by means of a large variety of interactive visual and sound stimuli design has received little attention (Bianchi- Berthouze, Kim, & Patel, 2007) (Bianchi- Berthouze, 2013) (Jofré, Rodríguez, Alvarado, Fernández, & Guerrero, 2016). Thus, the aim of this study is to fill, at least partially, such a gap by modelling a popular Mediterranean game (i.e. the Four-corner) first, into a more complex gaming form (i.e. the eight-corner) rather than into the wireless-based electronic human-computer interaction gaming situation. Our specific goal is to assess if the external visual stimuli electronic modelling could have the same effect on movements related to visual information searching. Moreover, when the human action is substituted by visual stimuli, the participant might perceive LEDs light stimuli as being included in the focus of attention and in-phase with the opponent's nonverbal behaviours of the real game (Kazanovich&Borisyuk, 2017). In addition, we aim at an in-depth investigation of the electronic modelling protocol reliability for decision-making enhancements, as well as visual attention training and rehabilitation. In addition, it is important to note that the relationship between exercise beliefs and exercise behaviours is reciprocal (Neupert, Lachman, &Whitbourne, 2009).

Thus, behaviour change is also determined by outcome expectations or a sense of controllability; that is, whether one expects one's actions to lead to desirable outcomes (Lachman, 2006; Lachman, Rosnick, Röcke, & Bosworth, 2009). Therefore, assessing expectations through results predictions would be important to evaluate the reliability of performance expectations between the eight-corner and the electronic modelling situation.
The key research question of this study was whether or not searching visual signals produced by the B-percept® modelling system (i.e. man-to-machine interaction), will make participants reproduce the same search behaviour and similar results of the eight-corner game (i.e. man-to-man interaction).

To answer the previous question, two experiments are presented in this paper: First, we reported a comparison of participant nonverbal behaviours in both of the studied situations. Second, we investigated the results of score prediction versus the real score (i.e. pretest, posttest, and real score).

METHOD

PARTICIPANTS

Sixty-four male participants (age 22 ± 1.8 yrs., height 1.73 ± 0.12 m, weight 68.2 ± 4.3 kg), recruited from a high school for engineering, gave informed consent to participate in the study for one month. Participants had no regular sports activities and no physical or visual impairment. The experiment protocol was performed in accordance with the declaration of Helsinki for human experimentation and was approved by the local ethical committee (The World Medical Association, 2001).

EXPERIMENTAL PROTOCOL

Participants were trained to practice the eight-corner game for 3 weeks (2 hours/day; 3 days/ week) from 3 PM to5 PM. The game consisted of joining eight participants (i.e. peripheral players) in an octagon shape and to set a ninth participant in the centre of the octagon (i.e. the central player), who was replaced every seven minutes.

The peripheral participants were instructed to communicate between each other using nonverbal signs (i.e. using body gestures, states, head movements), as quickly as possible without being detected by the central participant, who had to descry the maximum of signs in seven minutes by signalling their direction with the right hand.

APPARATUS

STIMULI - The eight-corner game was modelled by means of B-percept test devices. Thus, eight LEDs light emitting signals, were placed at a 5m distance and 1.03m height (i.e. mean height of the participants' hips) from the centre of the octagon to replace the participant's gestures (figure 1). The experiment process was fully recorded. B-percept is a ZigBee (IEEE 802.15.4- 2003) based wireless

protocol used for emitting the preprogramed simple and complex visual stimuli and for data processing through low power-demanding devices (i.e. XBee S2; 3.3v) (Tatsiopoulos&Ktena, 2009) (Faludi, 2010) (Yussoff, Abidin, Rahman, &Yahaya, 2010) (Nagaraja, Mangathayaru, Rajashekar & Kumar, 2016). For the aim of this research, the B-precept was mapped in a Personal Area Network (PAN) protocol to produce complex-randomized LED light signs for 7 minutes and replace observable gestures and behaviours used among participants to communicate as in the equation below (equation 1):

$$T_t = (T_{sig}n) + (T_{lat}(n-1)) + \sum_{i=1}^{n} E_i \quad (1)$$

(1)

(Tt) Total time of the test ; (Tsig) signal time; (n) number of trials; (T lat) latency time; (Ei) number of errors.

VIDEO RECORDING AND CODING - The participants' gestures and body movements were filmed using three high definition digital camcorders (60 Hz; Sony HDR XR500, Sony; Tokyo, Japan; HD 1080, 1CCD and shutter speed 1/4000th of a second).

The cameras were positioned in a form of a triangle at 10m distance and 1.60m tripods height from the observed participant (figure 1a).

Thus, the head, the body postures, the arms and the legs positions were clearly observable from the front side at any moment during testing.

The videos were edited and synchronized (i.e. Time Code TC-Link) to have a permanent facial recognition of participants by a professional video editor (figure 1b);

Magix video pro x5 Multicam- editing software (http://www.magix.com/gb/video-pro-x/detail/).

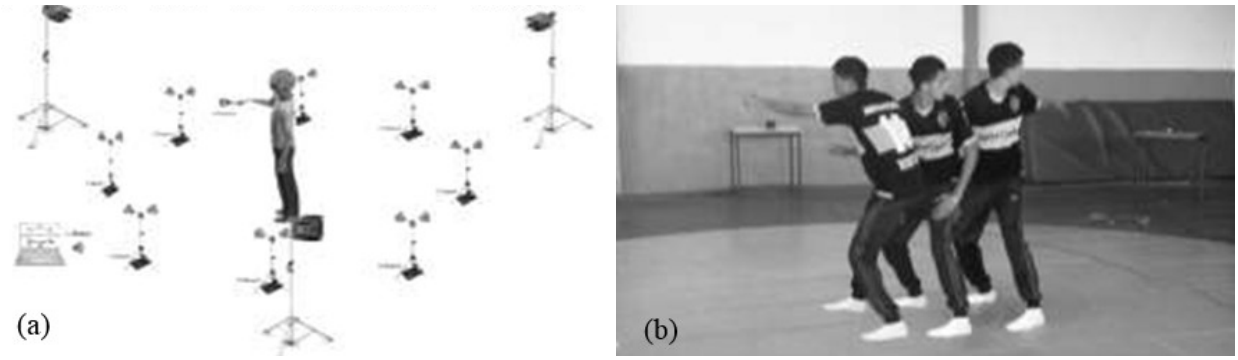


Figure 1: The B-percept® simulation system. The main panel shows, in (b), three video frames from the real-time signal search behaviour by the participants. The insets in (a) show the use of the visual search complex environment and the process used to record the participant's behaviour.

The Observer XT v.13 software (Noldus, 2008) (http://www.noldus.com/office/en/observer-xt-2.) was used for tracking and coding the common samples of behaviour. Moreover, this software allowed for collecting, managing, analysing, and presenting observational data through a timeline code. Thus, the observational data was reviewed with a synchronized display of the corresponding video images. The visual feedback during the video image coding was displayed in a window on the computer screen (figure 2), which gave advantage to the software-control jog, shuttle, and to make search functions easy. The Observer XT software is commonly used to study behaviours in psychology (Ducharme&Arcand, 2009) and social psychology (Zimmerman, Bolhuis, Willemsen, Meyer&Noldus, 2009). Three experts in physical education and sports were trained for three days (2 hours/day) to visualize sports videos and to code behaviours before they were asked to code the behaviour of each participant in both situations of the experimentation. Thus, themost repeated behaviours were summarized and sorted by categories (Hall et al., 2005). The Observer XT software automatically analysed the results. The means of the three experts' coding behaviours were used for statistical analysis.

SCORE PREDICTION - Participants were asked to predict their scores related to the estimated correct answers on a scale between zero and one hundred before and after the experimentation process (i.e. in the eight-corner game rather than in the B-percept test).

Thus, each participant, without personal identification to reduce social evaluative concerns, recorded the survey privately (Weinberg, Yukelson, & Jackson, 1980). A code number identified the results scale for each participant and the respondents were informed that their responses

will remain confidential and that they will only be used with number codes by the research staff.

STATISTICAL ANALYSIS - The consideration that takes part in this paper is the reliability of reproducing a social gaming nonverbal behaviour by an electronic modelling protocol. Thus, data are reported as mean ± standard deviation (SD) and confidence intervals at the level of 95% (95% CI). The effect size (d) was calculated using the GPOWER software (Bonn FRG, Bonn University, Department of Psychology). The following scale was used to interpret d: <0.2, trivial; 0.2 - 0.6, small; 0.6 - 1.2, moderate; 1.2 - 2.0, large; and> 2.0, very large. The distribution normality was acceptable for all variables. Therefore, the paired independent sample T-test was applied to compare the coded nonverbal behaviour of the central participant in two situations (i.e. the real game and the simulation).

Association between variables was assessed using Pearson correlation coefficients. The determination coefficient (R^2) was calculated to identify the common variance level between man-to-man interaction (i.e. eight-corner) and man-to-computer-aided electronic devices (i.e. B- percept). The agreement between gestures and movements in both studied situations was assessed using the Bland and Altman method (Bland & Altman, 2007). Significance was set at 0.05% (p≤ 0.05).

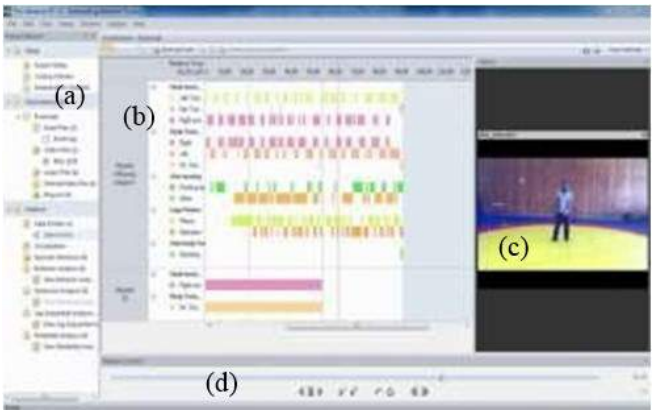


Figure 2: The user interface screenshot of B-percept signal search samples project in The Observer XT. This sample project shows the interaction between participants, with LED visual signals around him. His behaviour is videotaped and coded. (a): Project Explorer (b) : View Settings (c): Video window (d): Playback Control.

The reproducibility of behaviours was estimated by the degree of the repeated measurements concordance using the intra-class correlation coefficient (ICC).

The paired-sample t test was used to assess the score predictions means before and after the testing process. The proportions of the distance variance between predictions scores were assessed using the delta variation as shown in the equation (equation 2). Calculations and statistical analysis were performed using the MedCalc version 14.8.1.0 (Ostend, Belgium) and SPSS 21.0 (SPSS, Inc, Chicago, IL, USA).

$$\Delta_p x100 = \frac{BP\% - EC\%}{EC\%} \quad (2)$$

(Δp) predictions delta variation; (BP%) B-percept; (EC%) Eight-corner.

A total number of 128 videos was coded, half of which from B-percept modelling tests and half from the eight-corner game. The results are shown in Table 1. The mean percentage of the most repeated nonverbal behaviours in seven minutes of testing for each participant was summarized by experts into six categories (i.e. the head, the trunk, the arms, the legs and other movements). Thus, as shown in the Table below, the most repeated behaviours in both practices are head turning and trunk torsion by a total frequency of 60.44% in B-percept test and 59.91% in the eight-corner.

Additionally, out of the total observed gestures, in both practices, the participant was using 99.73% as search behaviour movements in B-percept and 99.76% in the eight-corner. However, the most significant correlation of movements comes from using head rotations ($r = 0.40$, $p < 0.001$), legs flexion/extension ($r = 0.54$, $p < 0.000$) and arms ($r = 0.37$, $p < 0.003$).

Table 2 shows the data from the comparison between coded behaviours in the studied situation (i.e. BP: B-percept; EC: eight-corner). Thus, the paired independent T-test values have shown no significant difference for head movement ($p = 0.210$) between the participants' nonverbal behaviour. In addition, the correlation between coded movements and gestures in B-percept and eight-corner was tested. It shows that, movements of the trunk, body, arms and others (i.e. not moving) are perfectly correlated. In parallel, the head and leg movements have a large correlation.

The determination coefficient, denoted here as R2, indicates that 73% to 94% of nonverbal interaction behaviours of the participant in the eight-corner game are predictable when practicing the B-percept test. Thus, a small to moderate Cohen's d effect size was calculated for the head, the trunk, the arms and the legs.

SCORE PREDICTION ANALYSIS - Table 3 shows summary statistics from the comparison of score predictions versus the real measured participants'

results in the B-percept test and the eight- corner game. Thus, as it can be seen from the table (below), there is a large difference between the participants' predictions before both the B-percept and the eight-corner game tests; Δp= 41.53%.

However, the after test score prediction difference becomes very small; Δp= 1.60% of participants are still different after both testing both activities.

Thus, the variance proportion of predicted results in eight corners in comparison with the known results in B-percept increased from R^2 = 0.3% before the test to R^2 =6.2% after the tests with a small effect size (d = 0.057). The data obtained from the comparison between the real, measured score in B-percept and eight-corner shows a Δp=15.79% analyses of the correlation test between B-percept and eight-corner as can be seen in (Table 3).

Table 1: Mean percentage of coded behaviours in the eight-corner game and B-percept modelling

Observed	Coded movement	Direction	EC-Game	B-percept
Head	Rotation	Right-Left	30.85%	31.03%
Trunk	Torsion	Right-Left	29.06%	29.41%
Body	Rotation	Right-Left	01.60%	01.64%
Arms	Extension	Pointing	23.12%	22.55%
Legs	Flexion/Extension	Vertical	15.13%	15.10%
Others	Not Moving	Static	0.24%	0.27%
		Total	**100%**	**100%**

Table 2: A comparison of gestures and body positions between the eight-corner game and B- percept®
(BP) B-percept® electronic modelling protocols; (EC) eight-corner game; (S) standing back somersault; (r) correlation coefficient; (R2) determination coefficient; (LOA) limits of agreement; (d) effect size; (+) trivial effect size (++) small effect size (+++) moderate effect size (++++) large.

BP vs EC	Mean ± Test SD	T-test (p)	r (95% CI)	R^2	ICC	Bias ± 95% LOA	d
Head	31.21±1.507 31.01±1.506	-0.760	0.87 (0.791-0.918)	75%	0.93	0.20±0.41	0.134+++
Trunk	29.43 ±2.16 29.13 ±2.33	-0.744	0.92 (0.871-0.950)	84%	0.95	0.30±0.6	0.136+++
Body	1.63 ±0.533 1.59 ±0.559	-0.404	0.97 (0.748-0.996)	73%	0.92	0.04±0.08	0.073+
Legs	15.03 ±2.49 15.04 ±2.40	0.037	0.88 (0.807- 0.924)	77%	0.94	0.00±0.0	0.006+
Arms	22.41 ±1.96 22.95 ±2.13	1.473	0.92 (0.864-0.948)	84%	0.94	0.50±1.1	0.272++++
Others	0.27 ±0.284 0.25 ±0.278	-0.268	0.97 (0.951-0.982)	94%	0.98	0.01±0.03	0.486++++

Table 3: Expectations of personal effectiveness before and after the testing process
(BP) B-percept® electronic modelling protocols; (EC) eight-corner game; (S) standing back somersault; (r) correlation coefficient; (R2) determination coefficient; (LOA) limits of agreement; (d) effect size; (+) trivial effect size (++) small effect size (+++) moderate effect size (++++) large.

BP vs EC	Mean ± Test SD	T-test (p)	r (95% CI)	R^2	ICC	Bias ± 95% LOA	d
BF-TEST	66.76±10.19 47.17±8.59	11.443	0.06 (0.192-0.298)	0.3%	0.04	1.462 ±1.4	1.90+
AF-TEST	39.21±11.17 39.85±6.14	-0.452	0.25 (0.003-0.466)	6.2%	0.35	0.995 ±1.09	0.057++
RS-TEST	31.10±7.72 36.93±6.45	-35.758	0.99 (0.998-0.999)	99.8%	0.84	0.83 ±0.27	0.75++

DISCUSSION AND CONCLUSIONS

The present research deals with the eight-corner game electronic modelling in which man-to-man interaction is highly prolific of nonverbal behaviours during the "players' action"(Dugas, 2011).

Messages, other than words, that participants use to communicate in the eight- corner are generally exchanged consciously and have a specific meaning to express regarding decision-making and intentions (Vinciarelli et al., 2009). However, some of them could be misleading, trying to convey unreal intentions to the opponent.

The coded movements and gestures of participants, as they were searching for the visual signals in B-percept test (e.g., Bianchi-Berthouze et al. (2007); Lausberg and Slöetjes (2008)), were consistent with the nonverbal behaviour coded when playing eight-corner.

The results of the inter-class correlation (Table 2) and the limits of agreement (figure 3) indicated a perfect reliability of the body and leg movements between both studied situations.

The B-percept visual stimuli modelled by a preprogramed randomizing java application make possible the reproduction of countless visual stimuli in eight directions around the participant.

Thus, the "math.Random" program (Lian, Hsiao, & Sung, 2013; Ross, 2002) produced stimuli in such a way that the same LED light direction was never repeated. Therefore, various directions and visual search behaviours were provided to the participants (i.e. using the same movements of the head, trunk, body, arms, legs and the static position).

These factors may explain the relatively good correlation (Table 2) between man-to-man behaviour modelling (i.e. the eight-corner) and man-to-computer-aided device interaction simulation (i.e. B-percept®).

During the eight-corner game training sessions, participants were highly motivated and excited. On the contrary, they were more attentive and quiet during the B-percept test. Thus, the comparison of nonverbal behaviour in both situations showed, in the first part of the analysis results, a perfect reliability of visual information searching behaviour.

However, the score predictions before testing were significantly different because the participants judged that it could be easier to have better results in the B- percept test than in the eight-corner. Therefore, no significant correlation was found between predictions before the tests in both situations (Table 3).
Moreover, the trivial determination coefficient (R2) means that it was not possible to predict the B- percept® scores from the eight-corner game results.

The posttest predictions data analysis reports no significant difference between score predictions in the eight-corner and B-percept®, which means that the participants have changed their judgments about their performance in the simulation model.

There are several possible explanations for this result, but it is maybe related to the participants' self-efficiency esteem.

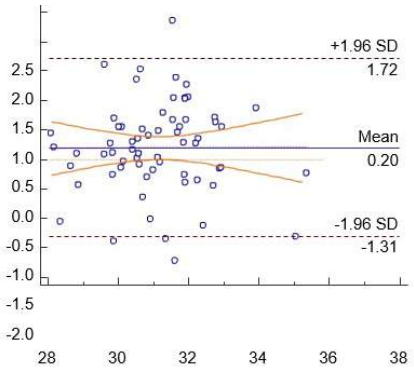
The examination of the participants' real scores in the B-percept test and the eight-corner (Table 1) indicates that the outcomes of the interactions' electronic modelling might be a very close nonverbal behaviour to the real game.

Thus, movements in both situations were perfectly correlated; r = 0.99. In addition, the determination coefficient (R^2) showed a high common variance between man-to-man interaction (i.e. the eight- corner) and man-to-computer-aided electronic devices (i.e. the B-percept®).

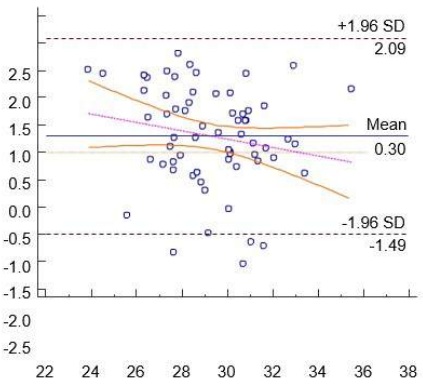
As result, it could be possible to predict the participant interaction behaviour in eight-corners through the results of the B-percept modelling process.

Returning to the question posed at the beginning of this study, it is now possible to state that the B-percept® modelling system could be proposed as an experimental simulation process, which could possibly help to make participants produce complex visual search behaviour through a visual modelling simulation as close as possible to the real gaming situations.

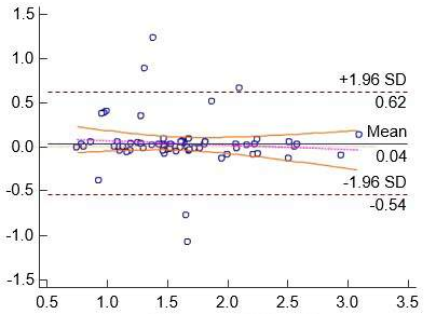
Although the current study is based on a small sample of participants, the findings suggest that the B-percept® modelling systems could be used in future research to assess and compare the effect of practicing sports and physical activities on complex visual attention and information searching behaviour, as well as for rehabilitation.



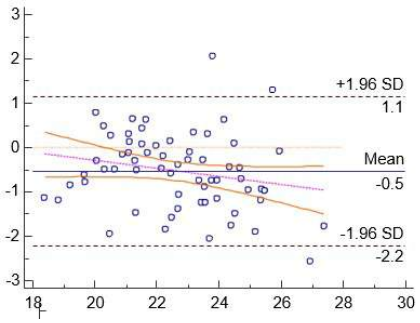
BP_MH and EC_MH Mean



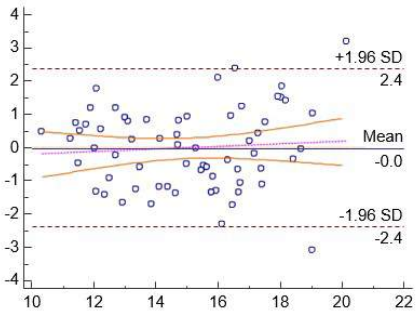
BP_MTR and EC_MTR Mean



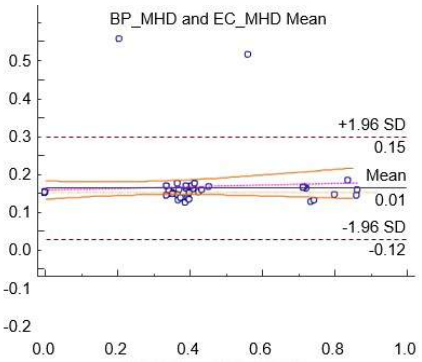
BP_MBDY and EC_MBDY Mean



BP_MHD and EC_MHD Mean



BP_MLGS and EC_MLGS Mean



BP_NMV and EC_NMV Mean

Figure 3: An illustration of Bland and Altman plots for the Head movements (MH), Trunk Movement (MTR), Leg Movement (MLGS), Body Movement (MBDY), Hand Movement (MHD) and No Movement (NMV) for the B-percept test (BP) and the Eight-corner game (EC).

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MODELIRANJE I PROCJENA PONAŠANJA VIZUALNE POTRAGE IGRAČA KORISTEĆI SISTEM ZASNOVAN NA INTERAKCIJI ČOVJEKA I RAČUNARA

Primjena bežičnih signala elektronske simulacije kao pristupa prepoznavanja ponašanja vizualne potrage nije jednostavan zadatak. Ovaj rad razmatra proces kreiranja modela ljudske interakcije u stvarnoj igri putem podražaja elektronske simulacije, što bi istraživačima interakcije čovjeka i računara (engl. HCI - HumanComputerInteraction: interakcija čovjeka i računara) u sportskoj i obrazovnoj nauci donijelo korist u smislu upotrebljavanja elektronskih modela i podražaja kao i mjerenja obilježja. Standardizacija metodologije bi omogućila poređenje rezultata, pouzdanost pronalazaka i lakšu integraciju različitih, kreiranih sistema za prepoznavanje ponašanja. Cilj ovog rada je predstaviti vodeći eksperimentalni proces validacije za modeliranje ponašanja putem B-percept®, te sistema za donošenje odluka i procjenu kako bi dali upute za buduća istraživanja modeliranja i procjene ponašanja koristeći interakciju čovjeka i računara.

Ključne riječi: Modeliranje, neverbalno ponašanje, igra osam uglova, B-percept.

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DIFFERENCES BETWEEN EUROPEAN AND NON-EUROPEAN COUNTRIES IN GOLD, SILVER AND BRONZE MEDALS WON

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ABSTRACT

The Olympic Games are a competition held every four years. Pierre de Coubertin had a major role in revitalizing the Olympic Games, and he considered them to be a tool for celebrating and rewarding sports excellence. The winners, in all disciplines and all sports that represent the Olympic Games, both individual and team, are awarded with medals: a gold medal (actually gold-plated silver) for the first place, a silver medal for the second place, and a bronze medal for the third place. This way of awarding medals was introduced at the Olympics in London, in 1908. According to the rules set by the International Olympic Committee (IOC), the members, National Olympic Committees (NOC), are ranked according to the number of gold medals won. The aim of this study is to systematise the results from the last four Summer Olympic Games and examine the differences between the first 40 European and non-European countries ranked by the number of gold, silver and bronze medals won on the Olympic Games in Rio 2016, London 2012, Beijing 2008 and Athens 2004. In this research, four Olympic Games were observed: Rio 2016, London 2012, Beijing 2008 and Athens 2004, as well as scores according to the number of medals won (gold, silver, and bronze) by the first 40 ranked countries. The results of this research showed that there are no statistically significant differences between the first 40 European and non-European countries ranked at the Olympics 2016, 2012, 2008 and 2004, considering the number of gold, silver and bronze medals won.

Keywords: The Olympic Games, ranking, medals, Summer Olympics, European and non-European countries.

INTRODUCTION

The Olympic Games are a competition held every four years. Pierre de Coubertin had a major role in revitalizing the Olympic Games, and he considered them to be a tool for celebrating and rewarding sports excellence.

The conference convened in 1894 and, at Coubertin's suggestion, founded the International Olympic Committee, in charge of the Olympics since then. The first modern age Olympics (they did not have the name Summer Olympics because, at the time, there was no mention of the need for Winter Olympics) were held in 1896, in Athens, and since then, they have been held every four years, except during the First and Second World Wars. The winners, in all disciplines and all sports that represent the Olympic Games, both individual and team, are awarded with medals: a gold medal (actually gold-plated silver) for the first place, a silver medal for the second place, and a bronze medal for the third place.

This way of awarding medals was introduced at the Olympics in London, in 1908. According to the rules set by the International Olympic Committee (IOC), the members, National Olympic Committees (NOC), are ranked according to the number of gold medals won. In this case, the countries that won the largest number of gold medals are favoured,

regardless of the number of total medals won. The Olympic Games, as well as the medals which are won, are still considered to be the greatest sports achievement.

Countries are focused on preparing their own Olympians, and invest big, in both financial and human resources, to win medals. This study will observe four Olympic Games, namely, Rio 2016, London 2012, Beijing 2008 and Athens 2004. The survey will give a clear overview of the official first 40 ranked countries per single Olympics - Rio 2016, London 2012, Beijing 2008 and Athens 2004 - considering the number of gold, silver and bronze medals won.

In this research, we want to investigate whether there is a difference between the first 40 European and non-European countries officially ranked at the Olympic Games in Rio 2016, London 2012, Beijing 2008 and Athens 2004 respectively, when taking into account the number of gold, silver and bronze medals won.

PURPOSE

The aim of this study is to systematise the results from the last four Summer Olympic Games and examine the differences between the first 40 European and non-European countries ranked by the number of gold, silver and bronze medals won on the Olympic Games in Rio 2016, London 2012, Beijing 2008 and Athens 2004.

HYPOTHESIS

(H1) There is a statistically significant difference between the first 40 European and non-European countries ranked at the Olympic Games in Rio 2016, considering the number of gold, silver and bronze medals won.

(H2) There is a statistically significant difference between the first 40 European and non-European countries ranked at the Olympic Games in London 2012, considering the number of gold, silver and bronze medals won.

(H3) There is a statistically significant difference between the first 40 European and non-European countries ranked at the Olympic Games in Beijing 2008, considering the number of gold, silver and bronze medals won.

(H4) There is a statistically significant difference between the first 40 European and non-European countries ranked at the Olympic Games in Athens 2004, considering the number of gold, silver and bronze medals won.

METHODS

Research description: In this research, four Olympic Games were observed: Rio 2016, London 2012, Beijing 2008 and Athens 2004, as well as scores according to the number of medals won (gold, silver, and bronze) by the first 40 ranked countries.

Subjects: In this study, 40 subjects, or rather countries that have participated and are ranked in the last four Olympic Games, were observed. The criteria for inclusion in the study and the statistical analysis were that the subjects had at least once participated in the last four Summer Olympics, and that they were ranked in the top 40 on the ranking table. The countries were divided in two groups: non-European (A) and European (B) countries. We divided the groups by the official IOC list of European NOCs.

Sample variables: The variables in this research represent the number of gold, silver and bronze medals won by the first 40 ranked countries in the last four Olympic Games, including Rio 2016, London 2012, Beijing 2008 and Athens 2004. Detailed subject and variable samples can be seen in Table 1.

Table 1: Non-European (A) and European (B) countries by medals won

Rio 2016				London 2012				Beijing 2008				Athens 2004			
NOC	**G**	**S**	**B**	**NOC**	**G**	**S**	**B**	**NOC**	**G**	**S**	**B**	**NOC**	**G**	**S**	**B**
A	46	37	38	**A**	46	28	29	**A**	48	21	29	**A**	36	39	26
B	27	23	17	**A**	38	29	21	**A**	36	38	37	**A**	32	17	14
A	26	18	26	**B**	29	17	19	**B**	22	15	22	**B**	28	26	36
B	19	17	19	**B**	20	18	31	**B**	19	13	15	**A**	17	16	17
B	17	10	15	**A**	13	9	8	**B**	16	10	15	**A**	16	9	12
A	12	8	21	**B**	11	19	14	**A**	14	15	17	**B**	13	16	20
B	10	18	14	**B**	11	11	13	**A**	13	11	8	**B**	11	9	13
A	9	3	9	**A**	8	15	12	**A**	9	7	9	**B**	10	11	11

B	8	12	8	**B**	8	9	11	**B**	8	9	10	**A**	9	12	9
A	8	11	10	**B**	8	4	6	**B**	7	16	19	**B**	9	9	12
B	8	7	4	**A**	7	14	17	**B**	7	5	4	**A**	9	7	11
B	8	3	4	**B**	6	6	8	**B**	7	3	12	**B**	8	6	3
A	7	6	6	**B**	6	4	9	**A**	6	4	4	**B**	8	5	9
B	7	4	6	**A**	6	2	5	**B**	5	10	4	**B**	8	5	6
A	6	6	1	**A**	5	6	2	**A**	5	3	2	**B**	6	6	4
A	6	3	2	**A**	5	3	7	**B**	4	5	2	**A**	5	2	3
B	5	3	2	**B**	4	10	4	**B**	4	1	4	**B**	5	0	1
A	5	2	4	**A**	4	4	4	**A**	4	1	2	**B**	4	9	9
A	4	9	5	**B**	4	3	3	**A**	3	9	8	**B**	4	2	1
A	4	3	15	**A**	4	0	2	**B**	3	5	2	**B**	3	11	6
A	4	2	7	**A**	3	5	9	**B**	3	5	1	**A**	3	6	3
A	3	5	9	**A**	3	2	2	**A**	3	4	10	**B**	3	3	5
A	3	2	3	**A**	3	2	1	**B**	3	4	6	**B**	3	2	5
B	3	2	2	**A**	3	1	6	**B**	3	3	1	**A**	3	2	0
A	3	1	4	**B**	3	1	2	**A**	3	2	4	**A**	3	1	4
B	3	1	2	**B**	2	5	3	**B**	3	2	2	**B**	2	5	6
A	3	1	0	**B**	2	5	2	**B**	3	2	1	**B**	2	4	1
B	2	6	7	**A**	2	4	6	**A**	2	10	15	**A**	2	3	2
B	2	6	3	**B**	2	4	3	**B**	2	2	3	**A**	2	2	2
A	2	6	2	**B**	2	2	6	**A**	2	2	2	**B**	2	2	2
B	2	5	4	**B**	2	2	6	**A**	2	2	1	**A**	2	2	1
B	2	4	2	**B**	2	2	0	**A**	2	2	0	**B**	2	2	0
B	2	3	6	**B**	2	1	2	**B**	2	1	4	**B**	2	1	9
A	2	3	2	**B**	2	1	1	**A**	2	0	4	**B**	2	1	5
B	2	2	2	**A**	2	0	1	**A**	2	0	1	**A**	2	1	2
A	2	2	2	**A**	1	6	11	**B**	2	0	0	**A**	2	1	2
B	2	2	0	**B**	1	4	3	**A**	1	3	4	**A**	2	1	0
B	2	1	4	**A**	1	3	4	**A**	1	3	0	**A**	2	0	4
B	1	7	10	**B**	1	3	3	**B**	1	2	2	**A**	2	0	1
B	1	4	4	**A**	1	3	3	**B**	1	1	4	**A**	1	4	3

Statistics: Descriptive statistics and systematisation of the subjects by the number of medals won per single Summer Olympics were observed. In addition, in the statistical analysis of the data, one-way analysis of variance (ANOVA) was used to determine the differences between the variables, i.e. the Olympic Games in Rio 2016, London 2012, Beijing 2008 and Athens 2004. Normality pertaining to the distribution of variables was observed to determine the parametric or nonparametric statistical analysis.

RESULTS AND DISCUSSION

The results of this research showed that there are no statistically significant differences between the first 40 European and non-European countries ranked at the Olympics 2016, 2012, 2008 and 2004, considering the number of gold, silver and bronze medals won.

The one-way ANOVA showed that there are no statistically significant differences in any of the mentioned cases.

When taking in account the Olympics in Rio 2016, the analysis of variance showed no differences between the European and non-European countries, considering the gold, silver and bronze medals won (Figure1).

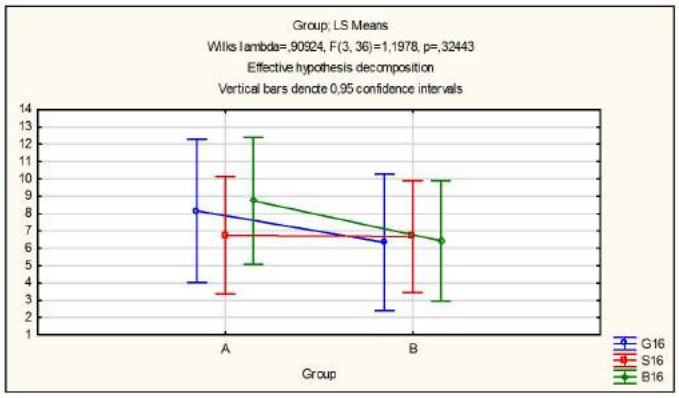

Figure 1: Differences between the countries at the Olympics in Rio 2016

The analysis of variance showed no statistically significant differences between the first 40 European and non-European countries ranked at the Olympics in London 2012, considering the number of gold, silver and bronze medals won, which can be seen in Figure 2.

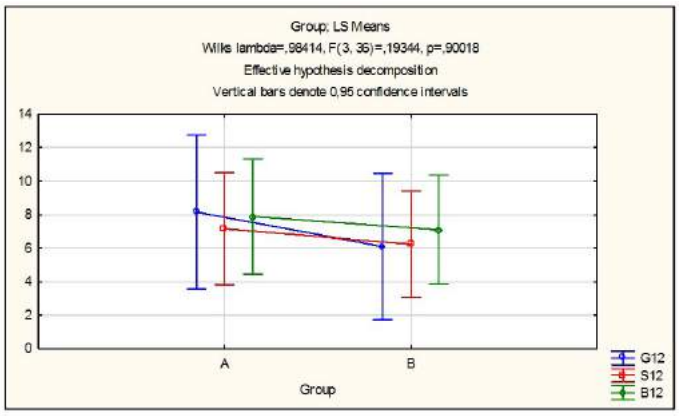

Figure 2: Differences between the countries at the Olympics in London 2012

The results of the ANOVA test also showed no statistically significant differences between the first 40 European and non-European countries ranked at the Olympics in Beijing 2008, as well as the Olympics in Athens 2004, considering the number of gold, silver and bronze medals won, which can be seen in Figures 3 and 4.

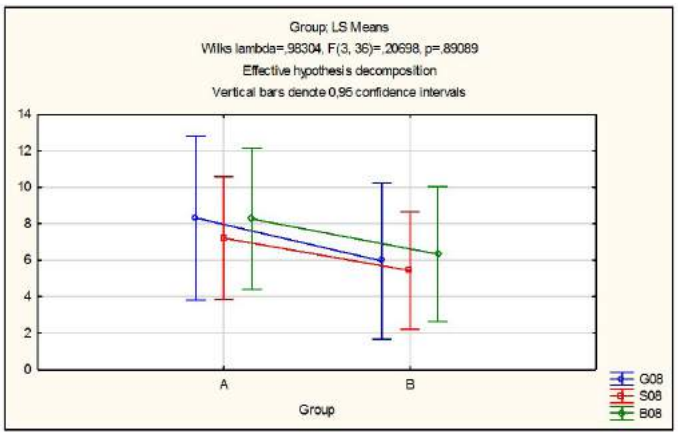

Figure 3: Differences between the countries at the Olympics in Beijing 2008

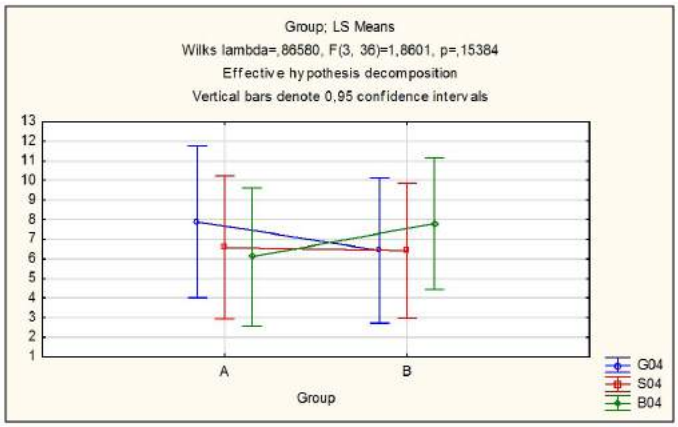

Figure 4: Differences between the countries at the Olympics in Rio 2016

Despite the fact that there are no statistically significant differences between the European and non-European countries in gold, silver and bronze medals won at the Olympics 2004, 2008, 2012 and 2016, when considering gold medals won, it can be said that the non-European countries won more gold medals, which is noted in the above mentioned figures. The first 40 countries ranked at the Olympic Games won more gold medals each time. The mean value of the silver medals won goes in benefit of the non-European countries only in Beijing and London, while the European countries scored better in Rio, whilst in Athens, the score was approximately the same. The non-European countries scored better when taking into account the bronze medals won, except at the Olympics in Athens 2004.

When considering the number of European and non-European countries ranked in the top 40, there are always 21 European and 19 non-European countries in the last four Olympic Games. Despite the fact that there are less non-European countries, they have better scores in gold medals won, just like we mentioned above. The absolute winner in each of the four mentioned Olympics is the USA, taking the first place in gold medals won every time. When taking in account the first five places in the last four Summer Olympic Games, the results are different. In Rio 2016, there are two non-European (USA, China) and three European (Great Britain, Russia and Germany) countries ranked in the first five places. Conversely, in London 2012, there are three non-European and two European countries ranked in the first five places with South Korea instead of Germany. In Beijing 2012, three European (Russia, Great Britain, Germany) and two non-European (China, USA) countries fall in the first five ranked countries, while in Athens 2004, the dominant countries are the non-European (USA, China, Australia and Japan) with the first four out of five ranks belonging to them, while the only European country was Russia.

We can conclude that there are no statistically significant differences between the first 40 European and non-European countries ranked by gold, silver and bronze medals won at the Olympic Games in Rio 2016, London 2012, Beijing 2008 and Athens 2004. When considering the above mentioned Table 1, we can also conclude that the dominant countries by gold medals won are the non-European ones with better scores, but when taking into account the number of countries ranked in the first 40 places, the dominant countries are the European ones with a score 21:19 at each mentioned Olympics.

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RAZLIKE IZMEĐU EUROPSKIH I NEEUROPSKIH ZEMALJA U OSVOJENIM ZLATNIM, SREBRNIM I BRONČANIM MEDALJAMA

Olimpijske igre su natjecanje koje se održava svake četiri godine. Glavnu ulogu u revitaliziranju Olimpijskih igara imao je Pierre de Coubertin, a koji je smatrao da su Olimpijske igre sredstvo za slavlje i nagradu sportske izvrsnosti. Pobjednici, u svim disciplinama i svim sportovima koje reprezentiraju Olimpijske igre, individualni i timski, nagrađuju se medaljama: za prvo mjesto zlatna medalja (uistinu pozlaćeno srebro), za drugo mjesto srebrena medalja i za treće mjesto brončana medalja. Ovakav način davanja priznanja traje od Olimpijskih igara u Londonu 1908. godine. Prema pravilima Međunarodnog Olimpijskog Komiteta, rangiranje članica, Nacionalnih Olimpijskih Komiteta, se vrši prema broju osvojenih zlatnih medalja. Cilj ove studije je sistematizirati rezultate zadnje četiri ljetne Olimpijske igre i utvrditi razlike između prvih četrdeset rangiranih, europskih i neeuropskih, zemalja prema broju osvojenih zlatnih, srebrenih i brončanih medalja na Olimpijskim igrama Rio 2016, London 2012, Peking 2008 i Atina 2004. U ovom istraživanju observirane su četiri pomenute Olimpijske igre, kao i rezultati prvih četrdeset rangiranih zemalja postignuti na istim prema broju osvojenih zlatnih, srebrenih i brončanih medalja. Rezultati istraživanja su pokazali da ne postoji statistički značajna razlika između prvih četrdeset rangiranih eropskih i neeuropskih zemalja prema broju osvojenih zlatnih, srebrenih i brončanih medalja na Olimpijskim igrama Rio 2016, London 2012, Peking 2008 i Atina 2004.

Ključne riječi: Olimpijske igre, rangovi, medalje, ljetne Olimpijske igre, europske i neeuropske zemlje.

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AN ANALYSIS OF DIFFERENCES BETWEEN ANXIETY LEVELS AMONG LONG – DISTANCE RUNNERS RELATED TO CATEGORIAL VARIABLES

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ABSTRACT

The relationship between anxiety and performance in a sports activity has been the subject of research conducted by many scientists around the world in the past thirty years. Scientists are dealing with this topic because they want to answer the question of whether it affects sports achievement. The aim of this study is to determine the differences in the degree of anxiety for long-distance runners in relation to categorical variables (gender, age, sports long-distance running, perception of success in competition and motivation for competition). Respondents who participated in the research were divided by gender, with 39 being women and 91 men aged 20 to 62 years. The survey questionnaire used in the work is CSAI-2 (Competitive State Anxiety Inventory-2) and a set of demographic questions for long-distance runners. The results show a difference in the degree of anxiety for long-distance runners in relation to gender, age, perception of competition success, motive for competition and long-distance competition.

Keywords: Anxiety, running, long-distance tracks, runners, questionnaire.

INTRODUCTION

It is generally accepted that in sporting activities, prior to the performance, there is an unpleasant or stressful state that can take on different forms and effects of anxiety.

The word anxiety derives from the Latin noun angor and the corresponding verb ango (to constrict). In our language, there are several other terms for anxiety such as: tension and the types of irrational and vague fear. Anxiety is present in athletes, whether they are dealing with amateur, professional or top sports. Therefore, the link between anxiety and sports success is one of the most intensively investigated areas in the field of sports psychology. This is understandable given the fact that an athlete is under constant pressure from the competition, so the ability to control anxiety is a crucial factor in a situation where two contestants (opponents) have very similar qualities (physical, technical, tactical ...).

The determination of the relationship between anxiety and sports performance has been the subject of numerous studies (Gould, Petlichkoff and Weinberg, 1984; Mikić, 1986; Feltz, 1988; Martens et al., 1990). Anxiety can also be defined as a personality trait and as a state (Spilberger, et al, 1970; Mikić, 1986). The state of anxiety is associated with transient excitement and tension,

while the personality line indicates a permanent characteristic of a person. Developing anxiety as a personality trait depends on personal dispositions and environmental influences and it is not present in all athletes, while competitive anxiety may exist to a certain degree in all athletes (Elgin, 2000). Anxiety is a "negative emotional state with a feeling of nervousness, worry, anxiety related to the activation or excitement of the body", and accordingly we can think of anxiety as "an unpleasant condition caused by a high level of excitement" (Weinberg & Gould, 1995; Cox, 2005). Although a certain level of anxiety is normal, and in some cases preferable before the competition, the high intensity of pre-competition anxiety is certainly not desirable and may have adverse effects on sports achievement, and long-term anxiety seriously affects the organism. In everyday life, in order to perform any activity our body must be "awake" and in "standby". This state of the organism in literature is called excitement. Inconvenience and anxiety are often used as synonyms, but that is not the case in all situations. According to Posner and Boiesu (1971), excitement is one of the three important components of attention; the other two are: selective attention and limited processing capacity. The more an athlete is alert, the more careful his focus is. Incitement is synonymous with excitement; an excited person is in the physiological state of readiness. This standby condition can be displayed on a continuum that goes from deep sleep to extreme excitement. The quality of an athlete's performance often depends on how much it is driven (Duffy, 1962; Malmo, 1959). The famous sports psychologist Richard Cox (2005) states that excitement is a neural psychological phenomenon that can be associated with negative (anxiety) and positive (excitement) affecters, but is not synonymous with either of them.

A multidimensional approach to the theory of anxiety state is developed by Martens (1970), suggesting that sports anxiety is multidimensional and, in accordance with such an approach, the author sets the multidimensional theory of anxiety. According to this theory, anxiety involves a somatic component, a cognitive component, and self-confidence.

Cognitive anxiety is defined as care, negative thoughts of the individual or their concerns about expected effects, as well as attention deficit and lack of concentration, reduction of one's own abilities, creation of images pertaining to defeat in one's head, etc.

Somatic anxiety is expressed as psychological reactions and symptoms in the individual manifestations such as rapid heart rate, high blood pressure, a feeling of "butterflies" in the stomach, rapid breathing, blushing, excessive sweating, trembling, or tension. One of the most effective ways to help athletes control their stress and anxiety is to support the development of their own self-esteem. A very effective way to build self-confidence is simulation training (Hardy, 1996). For athletes, this training involves practicing under pressure and learning how to effectively respond when they feel nervous.

The level of athletes' anxiety depends on both situational and individual factors. Situational factors relate to the importance of events and expectations, while individual factors place an emphasis on anxiety as a personality trait and care about performance, and as a focus of control (Jarvis, 2006).

The aim of this study is to determine the differences in the degree of anxiety for long-distance runners in relation to categorical variables (gender, age, sports long-distance running, perception of success in competition and motivation for competition).

RESEARCH METHODOLOGY

THE SAMPLE OF RESPONDENTS

The sample of respondents consisted of 130 persons (87 males and 43 females) included in the long-distance running program of 38.25 (SD = 9.48) years of age ranging from 15 to 62 years. The sample was later subdivided according to the categorical variables of the questionnaire.

THE SAMPLE OF VARIABLES

The research used two instruments:

1) Competitive State Anxiety Inventory- 2 (Martens, 1970; Mikić, 1986; Martens et al., 1990) consisting of 27 particles with a scale of 4 responses (not at all, a bit, quite, very). The questionnaire consisted of three subcategories: cognitive anxiety (9 particles) that refers to the expectation of a negative outcome, failure; somatic anxiety (9 particles) that relates to physical reactions before competition and sports; self-confidence (9 particles) that relates to faith in themselves and their abilities.

2) A set of categorical variables/responses from personal data of the race participants concerning gender, age, motive, length of racing career, the best result achieved in the half-marathon race and the subjective assessment of competitive quality.

DATA ANALYSIS

In order to determine the univariate differences for each subgroup of two categories, a T-test for independent samples was used (Mann - Whitney - U

test - nonparametric alternative), and, for subsamples with 3 or more categories, a univariate analysis of variance (ANOVA) (Kruskal Wallisova - non-parametric alternative) was used. The data were analysed with a statistical package Statistica 13.1.

RESULTS AND DISCUSSION

Basic descriptive parameters of categorical variables and a set of questions about the motivation for running.

Table 1: Basic descriptive parameters of categorical variables.

	N	μ	SD	Mod	Min	Max
How old are you?	130.00	38.25	9.48	35.00	15.00	62.00
How long have you been running?	128.00	7.53	8.73	3.00	0.50	42.00
How long have you been dealing with this discipline?	124.00	5.49	7.00	1.00	0.50	37.00
From one to five, evaluate how good a competitor is.	130.00	3.28	0.78	3.00	1.00	5.00
Evaluate the quality of your results from one to five.	130.00	3.26	0.70	3.00	1.00	5.00
From one to five, evaluate the difference between your training results and the competition.	128.00	3.10	0.87	3.00	1.00	5.00

Table 2: Descriptive parameters of a set of questions about motivation for running.

	Negative		Positive	
	f	%	f	%
Contest	81	62.30	49	31.70
Friendship	43	33.07	87	65.93
Money	124	95.38	6	4.62
Fun	77	59.23	53	40.77
Physical activity	54	41.54	76	58.46
Loss of Excess Pounds	104	80	26	20
Inner pleasure	34	26.15	96	73.85

The results of the survey show that the average age of participants is 38.25 years and the average period of their engagement in running is almost 9 years, out of which 7 years are dedicated to long - distance running. However, they have most often been engaged in running for 3 years, including 1 year dedicated to long - distance running. Looking at the pleasure and/or the perception of their achievements, the majority of respondents are considered to be average or good, both in training and in the competition. Analysing the motivation to run, it is evident that the majority of respondents cite internal satisfaction, socializing and physical activity as motivation. The lowest ranked reason for dealing with this activity is material benefit.

Table 3: Basic descriptive parameters of an anxiety questionnaire carried out on the entire sample

	N	AS	SD	Mode	Freq mode	Min	Max
1. I'm worried before the competition	130.00	1.69	0.79	1.00	62.00	1.00	4.00
2. I feel nervous	130.00	1.80	0.75	2.00	61.00	1.00	4.00
3. I feel relaxed	129.00	2.70	0.97	3.00	55.00	1.00	4.00
4. I doubt myself	126.00	1.52	0.76	1.00	76.00	1.00	4.00
5. I feel irritable	128.00	1.39	0.72	1.00	94.00	1.00	4.00
6. I feel comfortable	123.00	3.18	0.87		51.00	1.00	4.00

7. I'm worried I will not perform as well as I could.	128.00	1.70	0.81	1.00	61.00	1.00	4.00
8. My body is tense	130.00	1.80	0.79	2.00	62.00	1.00	4.00
9. I feel self-confidence	130.00	3.02	0.79	3.00	61.00	1.00	4.00
10. I'm worried I might be wrong to compete	128.00	1.64	0.76	1.00	65.00	1.00	4.00
11. I feel tense in the stomach	129.00	1.67	0.85	1.00	70.00	1.00	4.00
12. I feel safe	128.00	2.98	0.93	3.00	51.00	1.00	4.00
13. I'm worried I might be wrong to compete	127.00	1.64	0.82	1.00	71.00	1.00	4.00
14. My body is relaxed	130.00	2.87	0.93	3.00	59.00	1.00	4.00
15. I believe they can overcome the challenge posed	127.00	2.97	0.84	3.00	63.00	1.00	4.00
16. I'm worried I'm going to play badly	129.00	1.63	0.77	1.00	68.00	1.00	4.00
17. My heart hurts until I return home	128.00	1.93	0.82	2.00	53.00	1.00	4.00
18. I am convinced that I will compete well	127.00	2.89	0.79	3.00	71.00	1.00	4.00
19. I am concerned that I will not achieve the set goal	129.00	1.61	0.75	1.00	68.00	1.00	4.00
20. I feel the tone in my stomach	129.00	1.41	0.66	1.00	87.00	1.00	4.00
21. I'm mentally relaxed	129.00	2.98	1.00	4.00	48.00	1.00	4.00
22. I'm worried that others might be disappointed with my performance	130.00	1.43	0.76	1.00	90.00	1.00	4.00
23. My palms are sweating and sticky	130.00	1.29	0.62	1.00	102.00	1.00	4.00
24. I am very confident because I mentally visualized the achievement of the competition goal	130.00	2.73	0.90	3.00	54.00	1.00	4.00
25. I am concerned that I will not remain concentrated	130.00	1.35	0.65	1.00	94.00	1.00	4.00
26. My body is tense	129.00	1.82	0.92	1.00	59.00	1.00	4.00
27. I feel self-confident that I could succeed despite the pressure	127.00	2.98	0.89	3.00	52.00	1.00	4.00

The overall sample in the anxiety questionnaire shows a low level of anxiety because in almost all particles (1, 2, 4, 5, 7, 8, 10 ...) that describe negative experiences, the results are low, and the most common answers are "little", and "never". On the other hand, the particles that are positively oriented have the most common high answers.

Table 4: Analysis of differences in the degree of anxiety by gender (M-W-U test) - *p=0.05

	Sum - rank M	**Sum - rank F**	**U**	**Z**	**p value**
1. I'm worried before the competition	5533.50	2981.50	1705.50	-0.81	0.42
2. I feel nervous	5370.00	3145.00	1542.00	-1.62	0.10
3. I feel relaxed	5825.00	2560.00	1614.00	1.17	0.24
4. I doubt myself	5246.50	2754.50	1591.50	-0.78	0.43
5. I feel irritable	5490.00	2766.00	1749.00	-0.29	0.77
6. I feel comfortable	5202.50	2423.50	1562.50	0.63	0.53
7. I'm worried I will not perform as well as I could.	5679.00	2577.00	1716.00	0.34	0.73
8. My body is tense	5731.50	2783.50	1837.50	0.16	0.87

9. I feel self-confidence	6123.00	2392.00	1446.00	2.10	0.04
10. I'm worried I might be wrong to compete	5589.00	2667.00	1721.00	0.53	0.59
11. I feel tense in the stomach	5373.50	3011.50	1632.50	-1.08	0.28
12. I feel safe	5697.00	2559.00	1656.00	0.76	0.45
13. I'm worried I might be wrong to compete	5653.00	2475.00	1614.00	0.77	0.44
14. My body is relaxed	6153.50	2361.50	1415.50	2.25	0.02
15. I believe they can overcome the challenge posed	5603.00	2525.00	1622.00	0.83	0.40
16. I'm worried I'm going to play badly	5487.00	2898.00	1746.00	-0.51	0.61
17. My heart hurts until I return home	5407.00	2849.00	1579.00	-1.04	0.30
18. I am convinced that I will compete well	5860.00	2268.00	1407.00	1.83	0.07
19. I am concerned that I will not achieve the set goal	5429.50	2955.50	1688.50	-0.80	0.42
20. I feel the tone in my stomach	5542.00	2843.00	1714.00	-0.57	0.57
21. I'm mentally relaxed	6101.50	2283.50	1380.50	2.24	0.02
22. I'm worried that others might be disappointed with my performance	5681.00	2834.00	1853.00	-0.08	0.93
23. My palms are sweating and sticky	5863.50	2651.50	1705.50	0.81	0.42
24. I am very confident because I mentally visualized the achievement of the competition goal	5850.00	2665.00	1719.00	0.75	0.45
25. I am concerned that I will not remain concentrated	5668.50	2846.50	1840.50	-0.15	0.88
26. My body is tense	5732.00	2653.00	1750.00	0.38	0.70
27. I feel self-confident that I could succeed despite the pressure	5440.50	2687.50	1741.50	0.33	0.74

Analysing the univariate differences of anxiety questionnaires by gender, the difference was found only in particles 9, 14 and 21, where it is evident from the basic descriptive parameters that men are more relaxed and more confident than female racers. In 2003, Faganel's research showed similar results.

Table 5: Analysis of differences in the degree of anxiety with regard to age (Kruskal - Wallis ANOVA). - *p=0.05

	H	**p**
1. I'm worried before the competition	3.35	0.19
2. I feel nervous	9.15	0.01
3. I feel relaxed	0.19	0.90
4. I doubt myself	4.94	0.08
5. I feel irritable	12.13	0.00
6. I feel comfortable	3.43	0.18
7. I'm worried I will not perform as well as I could.	3.02	0.22
8. My body is tense	7.66	0.02

9. I feel self-confidence	1.00	0.60
10. I'm worried I might be wrong to compete	0.24	0.89
11. I feel tense in the stomach	9.11	0.01
12. I feel safe	2.11	0.35
13. I'm worried I might be wrong to compete	2.58	0.27
14. My body is relaxed	4.80	0.09
15. I believe they can overcome the challenge posed	9.56	0.00
16. I'm worried I'm going to play badly	6.56	0.04
17. My heart hurts until I return home	11.42	0.00
18. I am convinced that I will compete well	0.77	0.68
19. I am concerned that I will not achieve the set goal	5.40	0.06
20. I feel the tone in my stomach	5.62	0.06
21. I'm mentally relaxed	2.19	0.33
22. I'm worried that others might be disappointed with my performance	1.93	0.38
23. My palms are sweating and sticky	4.09	0.13
24. I am very confident because I mentally visualized the achievement of the competition goal	1.34	0.51
25. I am concerned that I will not remain concentrated	4.89	0.08
26. My body is tense	3.19	0.20
27. I feel self-confident that I could succeed despite the pressure	2.27	0.33

The overall sample in the anxiety questionnaire shows a low level of anxiety because in almost all particles (1, 2, 4, 5, 7, 8, 10 ...) that describe negative experiences, the results are low, and the most common answers are "little", and "never". On the other hand, the particles that are positively oriented have the most common high answers.

Table 6: Analysis of differences in the degree of anxiety with regard to the length of long-distance running (Kruskal Wallis ANOVA).- *p=0.05

	H	**p**
1. I'm worried before the competition	4.98	0.08
2. I feel nervous	6.37	0.04*
3. I feel relaxed	4.94	0.08
4. I doubt myself	6.58	0.03*
5. I feel irritable	4.68	0.09
6. I feel comfortable	6.66	0.03*
7. I'm worried I will not perform as well as I could.	3.36	0.18
8. My body is tense	6.00	0.04*

9. I feel self-confidence	3.68	0.15
10. I'm worried I might be wrong to compete	0.34	0.84
11. I feel tense in the stomach	3.33	0.18
12. I feel safe	2.39	0.30
13. I'm worried I might be wrong to compete	1.02	0.59
14. My body is relaxed	8.67	0.01*
15. I believe they can overcome the challenge posed	0.52	0.76
16. I'm worried I'm going to play badly	0.76	0.68
17. My heart hurts until I return home	10.25	0.00*
18. I am convinced that I will compete well	0.25	0.88
19. I am concerned that I will not achieve the set goal	1.12	0.57
20. I feel the tone in my stomach	2.59	0.27
21. I'm mentally relaxed	9.00	0.01*
22. I'm worried that others might be disappointed with my performance	1.33	0.51
23. My palms are sweating and sticky	6.61	0.03*
24. I am very confident because I mentally visualized the achievement of the competition goal	1.66	0.43
25. I am concerned that I will not remain concentrated	0.91	0.63
26. My body is tense	5.46	0.06
27. I feel self-confident that I could succeed despite the pressure	3.56	0.16

Table 6 shows the degree of anxiety according to the length of long - distance running. Long-distance runners who have been engaged in running for up to three years have expressed positive cognitive anxiety and self-confidence, while Group 2, who have been training between 3 and 10 years, express negative cognitive anxiety. The most experienced group is the most confident; we see it through the values in particles 6, 9, 12, 14, 15, 21 and 27.

Table 7: Analysis of differences in the degree of anxiety with regard to perception of success in the competition (Kruskal - Wallis ANOVA). - *p=0.05

	H	**p**
1. I'm worried before the competition	2.12	0.71
2. I feel nervous	7.31	0.12
3. I feel relaxed	6.23	0.18
4. I doubt myself	2.11	0.71
5. I feel irritable	3.89	0.42
6. I feel comfortable	4.18	0.38
7. I'm worried I will not perform as well as I could.	3.39	0.49

8. My body is tense	2.95	0.56
9. I feel self-confidence	6.65	0.15
10. I'm worried I might be wrong to compete	3.95	0.41
11. I feel tense in the stomach	5.62	0.22
12. I feel safe	4.39	0.35
13. I'm worried I might be wrong to compete	2.88	0.57
14. My body is relaxed	2.14	0.71
15. I believe they can overcome the challenge posed	8.57	0.07
16. I'm worried I'm going to play badly	2.61	0.62
17. My heart hurts until I return home	5.26	0.26
18. I am convinced that I will compete well	10.27	0.03*
19. I am concerned that I will not achieve the set goal	5.12	0.27
20. I feel the tone in my stomach	4.88	0.29
21. I'm mentally relaxed	2.59	0.56
22. I'm worried that others might be disappointed with my performance	1.05	0.90
23. My palms are sweating and sticky	0.85	0.93
24. I am very confident because I mentally visualized the achievement of the competition goal	6.80	0.14
25. I am concerned that I will not remain concentrated	2.64	0.61
26. My body is tense	9.85	0.04*
27. I feel self-confident that I could succeed despite the pressure	7.84	0.09

According to the subjective assessment of success in the competitions, the majority of respondents answered that they are considered good, about 70 of them. Then, they are followed by those who are considered quite good, bad, excellent and very bad at competitions. In the analysis of the differences, the particles 18 and 26 are highlighted. Particle 18 shows how high is the conviction that "I will compete well". Those who have self-assessed themselves as excellent runners are the most self-reliant, followed by the categories "quite good" and "good" with the category "bad" at the end. Particle 26 (The body is taut) has the highest value in the category "quite good", followed by the categories of "excellent" and "good". Two respondents stated the category "bad".

Table 8: Analysis of differences in the degree of anxiety according to motivation for competition (M-W-U test) - *p=0.05

	Sum - rank not motivated	**Sum - rank motivated**	**U**	**Z**	**p value**
1. I'm worried before the competition	5114.50	3400.50	1793.50	-0.92	0.36
2. I feel nervous	5043.00	3472.00	1722.00	-1.26	0.21
3. I feel relaxed	5246.00	3139.00	1914.00	0.22	0.83
4. I doubt myself	5044.50	2956.50	1828.50	0.14	0.89
5. I feel irritable	4742.00	3514.00	1502.00	-2.05	0.04*
6. I feel comfortable	4780.50	2845.50	1764.50	0.03	0.97

7. I'm worried I will not perform as well as I could.	4996.00	3260.00	1756.00	-0.80	0.42
8. My body is tense	5243.50	3271.50	1922.50	-0.30	0.77
9. I feel self-confidence	5327.50	3187.50	1962.50	0.10	0.92
10. I'm worried I might be wrong to compete	5217.00	3039.00	1896.00	-0.03	0.97
11. I feel tense in the stomach	5096.50	3288.50	1856.50	-0.50	0.62
12. I feel safe	4927.00	3329.00	1606.00	-1.47	0.14
13. I'm worried I might be wrong to compete	5305.00	2823.00	1695.00	0.92	0.36
14. My body is relaxed	5288.50	3226.50	1967.50	-0.08	0.94
15. I believe they can overcome the challenge posed	4765.50	3362.50	1525.50	-1.77	0.08
16. I'm worried I'm going to play badly	5343.50	3041.50	1865.50	0.38	0.70
17. My heart hurts until I return home	5136.00	3120.00	1896.00	-0.12	0.91
18. I am convinced that I will compete well	4906.00	3222.00	1666.00	-1.07	0.29
19. I am concerned that I will not achieve the set goal	5043.00	3342.00	1803.00	-0.76	0.45
20. I feel the tone in my stomach	5239.00	3146.00	1918.00	-0.12	0.90
21. I'm mentally relaxed	5378.00	3007.00	1831.00	0.55	0.58
22. I'm worried that others might be disappointed with my performance	5492.00	3023.00	1798.00	0.89	0.37
23. My palms are sweating and sticky	5373.00	3142.00	1917.00	0.32	0.75
24. I am very confident because I mentally visualized the achievement of the competition goal	5134.50	3380.50	1813.50	-0.82	0.41
25. I am concerned that I will not remain concentrated	5299.50	3215.50	1978.50	-0.03	0.98
26. My body is tense	5019.00	3366.00	1779.00	-0.88	0.38
27. I feel self-confident that I could succeed despite the pressure	4861.00	3267.00	1780.00	-0.65	0.52

From the data in (Table 8), it is visible that self-confidence and positive cognitive anxiety are characteristic for the Group that is motivated for the competition. In the analysis, the difference in the degree of anxiety, according to motivation conditioned by competition, is separated by particle number 5 (I feel irritable) in a way that those with a higher degree of motivation are at the same time more irritated. Jones et al. (1995) divided the athletes into two groups; highly motivated and those with low motivation due to the competition. The results have shown that individuals in the high expectation group manage the situation and see symptoms of anxiety as a trigger rather than a retarder. The desire for success in the competition is the internal motivation of athletes, while the external motivation appears in many forms (Mikić, 1986). Often, they are money, praise, rewards, etc.

CONCLUSION

The aim of this study was to determine the differences in the degree of anxiety manifestation for long-distance runners and in relation to gender, age, motive for participation in the race, the length of the racing career and perception of success in the competition. The data were collected by the competitive questionnaire Competitive State Anxiety Inventory (CSAI-2) before the international race "Ultramaraton Osijek-Apatin", resulting in 130 completed questionnaires, which are also the sample of respondents.

Taking into account the findings of the above mentioned research, the basic assumptions of this research are confirmed:

- There are significant gender differences in the expression of sports anxiety. Women show a lower level of sports self-confidence and a higher degree of cognitive and somatic anxiety than men.
- Race participants with longer long-distance running career have less intense somatic and cognitive anxiety intensity.
- There are significant differences in the expression of sports anxiety between athletes with a different motive of achievement. A lower level of somatic anxiety and higher sports self-confidence is expected in athletes with a lower achievement motive.
- There are significant differences in the expression of sports anxiety in relation to the level of sports success. Top athletes exhibit a higher degree of self-confidence and a lower degree of cognitive and somatic anxiety compared to standard and recreational athletes.
- Long – distance runners show different types, intensities and the structure of anxiety before the performance.

The obtained results are important not only for researchers in order to better understand anxiety in sports context, but also for practitioners, coaches and athletes themselves. In this research, we deal with anxiety as a situation of long distance running, but, in the future, we need to consider anxiety as a personality trait. It would also be useful to examine and establish a link between some other factors important for the confidence of athletes such as the coach style with sports achievement. Further research is needed to fully understand the way psychological factors influence the achievement of athletes, or to help athletes eliminate factors that impede the realization of their potentials.

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ANALIZA RAZLIKA U STUPNJU ANKSIOZNOSTI TRKAČA DUGIH PRUGA U ODNOSU NA KATEGORIJALNE VARIJABLE

Povezanost anksioznosti i uspješnosti u sportskoj aktivnosti predmet je istraživanja mnogih znanstvenika širom svijeta u proteklih trideset godina. Znanstvenici se bave ovom temom jer žele odgovoriti na pitanje da li ona utječe na sportsko postignuće. Cilj ovog istraživanja je utvrđivanje razlika u stupnju anksioznosti trkača dugih pruga u odnosu na kategorijalne varijable (spol, uzrast, sportski staž trčanja na duge pruge, percepcija uspjeha na natjecanju i motivacija za natjecanje). Ispitanici koji su sudjelovali u istraživanju podijeljeni su prema spolu, od kojih je 39 žena i 91 muškarac u dobi od 20 do 62 godine. Anketni upitnik korišten u radu je CSAI-2 (engl. Competitive State Anxiety Inventory-2), te set demografskih pitanja namijenjenih dugoprugašima. Rezultati pokazaju razliku u stupnju anksioznosti trkača dugih pruga u odnosu na spol, uzrast, percepciju uspjeha na natjecanju, motiv za natjecanje i sportski staž natjecanja na duge pruge.

Ključne riječi: Anksioznost, trčanje, duge pruge, trkači, anketni upitnik.

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PHYSIOLOGICAL EFFECTS OF WARM-UP AND PROBLEMS RELATED TO TEAM SPORTS

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ABSTRACT

In this paper, the aims and all the factors related to the warm-up phase, which can have a positive effect on performance and allow each player a good workout or match, whatever their competitive level, will be taken into consideration. The results of several scientific papers will allow us to better understand and more accurately motivate the methodological choices and procedural attentions, while respecting the characteristics of team sports. In this paper, we will investigate the effects of warm-up, depending on different procedures and how it can affect sports performance and prevention of joint muscle injuries. We will then analyse the effects that can produce good or bad warm-up and how much breaks during play can affect muscle temperature in team sports games. Finally, we will investigate which procedure modes can be used to achieve a general effective activation for the purpose of sport performance.

Keywords: Muscle temperature, pauses during the game, methodology, exercises, sports performance.

INTRODUCTION

Warming up is a practice performed before physical-sports performance to enable the body to face the workout and match in the best possible conditions, improving physical performance and reducing the risk of injury (Safran et al., 1988). Is a widely accepted practice in the modern sporting environment and an essential one for attaining optimal performance (Tiziana et al., 2017, McGowan et al., 2015).

It is also essential for intermittent training to prevent damages (Rago et al. 2017, Gaetano, Rago 2014) and for particular skills needed during an intensive sports game such as a volleyball serve (Parisi& Raiola, 2014ab). Furthermore, the other aspects of pedagogical value (D'Isanto 2016, Di Tore et al., 2016, Di Tore, D'Isanto, 2016) pertaining to warm-up have to be taken into consideration for their beneficial effects on the athletes. The main goals of warming up are progressive preparation, from a physiological point of view, for training or a match, prevention of muscular injuries, the need to recall the technical skills before the start of the race, to achieve maximum concentration and psycho-physical activation (Raiola, 2015ab, Raiola, D'Isanto, 2016ab). At a physiological level, it means increasing vasodilation, supplying blood to the muscles and thus promoting nutrient intake and gaseous exchange for muscles in activity, increasing nerve impulses to the muscle, improving dross disposal, and increasing body temperature in the way that the activity of the enzymes, responsible for the production of energy, may be optimized (Birch et al., 2005).

It is believed that increased body temperature through warming up improves muscle function and elasticity, increases muscle tissue strength to lacerations, provides a greater connective tissue extensibility within the muscle, decreases muscle viscosity (Szymanski D., 2001) and increases the metabolic level and the extensibility of soft tissues (Clark et al., 2007). The increase in temperature also has a significant positive effect on muscular strength and power (Kenney et al., 2011) and it improves joint mobility (Sapega et al., 1981), reactivity

and rate of strenght development (Sargeant AJ, 1987). A large number of physiological mechanisms have been examined to ascertain their contributions to performance and responses to different warm-up strategies (Raiola, 2011ab). Technological advances over the past decade have also facilitated the emergence of new types of warm-up strategies (Faulkner et al., 2013). The aim of this paper is to investigate the effects of warm-up and how it can influence sport performance and prevention of joint muscle injuries through a careful selection of a series of exercises that should facilitate the achievement of a general and specific goal, such as increased vascularization, central and peripheral temperature, and recall the main technical-tactical qualities associated with sports discipline.

METHOD

The approach is theoretically argumentative for the part relating to the review of scientific literature on training theory and interpretive of the warm-up results.

It is primarily used to summarize and deduct the complexity of the scientific idea of research and how it applies in the practices of warming up for team sports games.

DISCUSSION

Warming up is an important phase in preparation for the race and it involves different aspects, from psychological to technical factors (Figure 1).

Figure 1: Main purposes of warm-up

The warm-up period is recognized as an opportunity to mentally prepare for an upcoming event by providing time for athletes to concentrate on the task (Cirillo et al, 2016). Many athletes complete some form of mental preparation prior to competition tasks (Tod et al., 2005). Warm-up is used to raise the body temperature, but energy expenditure is needed, which implies that it should not be extensive for the purpose of the race; so it is necessary to avoid carrying out highly intensive exercises during the warm-up phase. The main levels involved in the temperature increase are the peripheral muscle level and the central corporeal:

- at the peripheral muscle level, the goal is to increase vascularization of the various muscle groups involved in exercise or competition (Mastevoroi, 1964);
- at central corporeal level, an increase in body temperature of 2° C favours greater effectiveness of the chemical reactions in the organism and this elevation should be achieved through a succession of exercises in which the intensity gradually increases (Jock, Uckert, 2001).

After an active warm-up, there is an increase in total VO and a blunted blood lactate response during exercise compared to the absence of warm-up (Gray, Nimmo, 2001). These results have suggested that the elevation in muscle temperature after an active warm-up indicated a potential for increased blood flow to the working muscle, thereby increasing the aerobic contribution to energy metabolism at the onset of the exercise.

One of the main outcomes associated with warm-up is an increase in body temperature. Increases in muscle temperature are reportedly accompanied by increases in muscle metabolism (Gray et al., 2011) and muscle fibre conduction velocity (Pearce et al., 2012). Performance improvements in exercise tasks preceded by a warm-up are generally attributed to temperature-related mechanisms (Racinais, Oksa, 2010).

Figure 2: Effects resulting from temperature increase (modified by Bishop, 2003)

Effects dependent on the temperature increase	Effects that are not dependent on the temperature increase
-Reduction in muscle viscosity	- Increased consumption of O_2
- Reduction in muscular rigidity	
- Increased nervous conduction	
- Increased degradation of the ATP and PC	
- Thermoregulation increase	

The increase in muscle temperature results in a reduction of viscosity in the muscles and joints, resulting in decreased risks of adhesion and possible breaking of muscular fibre, thus obtaining better articular fluidity due to a decreased passive resistance of the joints (figure 2). Stewart et al. (2003) studied, by way of electromyography, the effects of active heating, conducted using a cycloergometer at an intensity of 45% VO2 max (for about 15 minutes, until an increase in muscle temperature of 3° C was obtained). The electromyography values showed an increase in the average frequency for the experimental group compared to the control group. Therefore, they concluded that the major speed of the nervous stimulus conduction had been determined during warm-up. The increase in temperature leads to an increased glycogenolysis, glycolysis and degradation of the ATP and the phosphocreatine (Febbraio et al., 1996). In Fig. 3, we can observe the influence of muscle temperature on the anaerobic process of ATP synthesis, especially when the temperature changes from 35 ° C to 40 ° C.

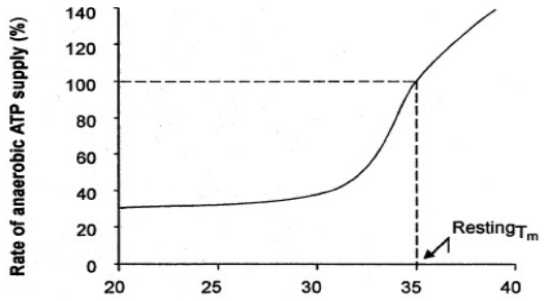


Figure 3: Anaerobic adenosine triphosphate (ATP) supply during exercise at different muscle temperatures (Bishop, 2003)

Increasing muscle temperature implies an accumulation of heat in the body and this aspect represents a limiting factor for performance, therefore, in long-term efforts, such as in team sports (football, basketball, volleyball, etc.), it is not desirable to elevate the muscular and central temperature too much. Among the effects that do not depend on the temperature increase, it is good to note that if you increase the O2 consumption level, with appropriate warm-up, you will face the match with a higher contribution of aerobic mechanisms, while anaerobic reserves can be restored, in large part, during the minutes separating the end of the warm-up phase and the start of the match. This procedure is fundamental for team sports, because, even if the pause between the end of the warm-up and the start of the match exceeds 5 minutes, the O2 level decreases and the advantageous effect obtained would be lost.

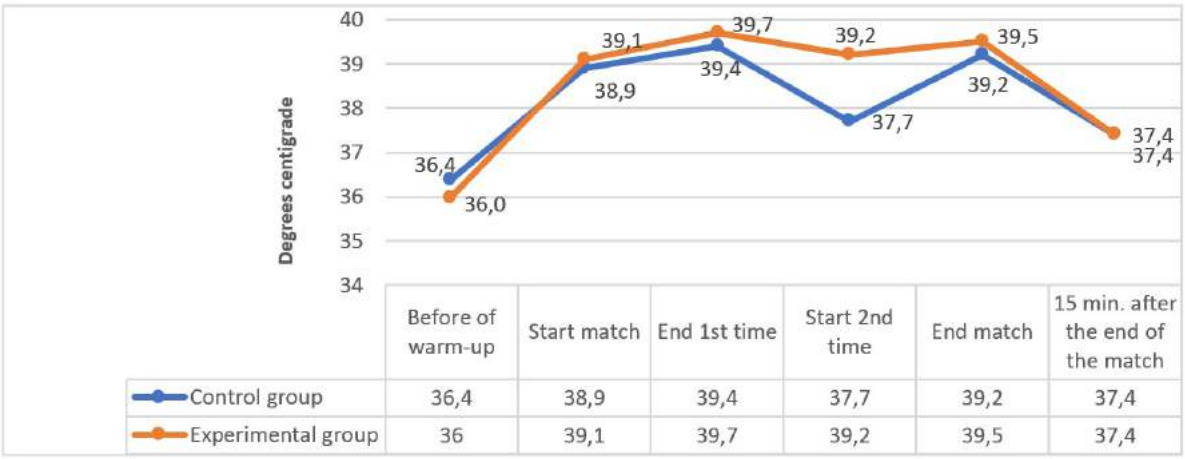
The efficacy of this warming up procedure is confirmed by several studies that demonstrate a greater contribution of aerobic processes or a lesser oxygen debt (Prampero et al., 1970). Athletes competing in field-based team sports, such as football, basketball and volleyball typically complete an active warm-up comprised of running and mobility exercises, as well as sport specific drills, with or without the ball, prior to a competitive match (Zois et al., 2011). These pre-match warm-ups on average last 30 min, with a 5-10 min transition between the end of the warm-up and the start of the match. A 10–15 min break between the first and second halves is also common (Towlson et al., 2013).

METHODOLOGICAL INDICATIONS FOR GOOD MUSCULAR WARMING

An increase in muscle temperature depends on local vascularization. In order to achieve this result, localized muscle contractions must be utilized through analytical movements, with a minimum of amplitude and intensity, and minimum resistance (between 20% and 50%). Masterovoi (1964) has shown that certain methods used as warm-up do not produce the desired result. In fact, if we analyse the classic exercises typically used in team sports, we will notice that exercises like slow running, stretching, etc. are most often utilised.

For example, slow running, often used by players in team sports, both at the beginning of training and of the match, produces contractions of the leg muscles that are less suitable for effective vascularization. Instead, it is exactly the shortening-elongation phase that stimulates vascularization and hence a more effective local thermic increase. The same stretching exercises (passive stretching) seem to be less suitable to stimulate vascularization. Alter (1996) has shown that stretching results in isometric high muscle tension and causes a break in blood irrigation, a completely opposite result of the vascularization effect to be sought. In fact, in many scientific conclusions, it has been stated that stretching as a method of warming up carries a negative effect on the athletes' performance capacity (Altavilla, 2014, Raiola, 2014, Gaetano, 2012). Consequently, if the vascularization process is badly conducted and cannot be completed during the warm-up phase with changes of direction, sprint, sliding, i.e. with all those movements that recall the techniques of sports discipline (Altavilla& Raiola, 2014, 2015), you do not get the vascularization effect, so the muscle temperature will not increase, or rather it could be even lower and the players will be in the condition of "no warming" until the end of the training or the match.Team sports have their own model of performance, in fact, they provide for short-term efforts, linked together, in repeated sequences many times, as well as for long-term efforts.

Considerable importance has been attributed to the pause between two halves in team sports games. In fact, as can be seen from figure 4 (Mohr et al., 2004), during the game interval (between the 1st and 2nd halves), a significant decrease in muscle temperature is observed, especially for the control group that did not carry out warm-ups during the pause between the 1st and 2nd halves of the game, while the experimental group that carried out the warming up phase during the pause, between the 1st and 2nd halves of game, maintains a temperature approximately equal to that achieved during the 1st half of the game. Consequently, an appropriate strategy should be set up to keep the temperature reached just after the warming up phase and prolonged pauses of the game.



	Before of warm-up	Start match	End 1st time	Start 2nd time	End match	15 min. after the end of the match
Control group	36,4	38,9	39,4	37,7	39,2	37,4
Experimental group	36	39,1	39,7	39,2	39,5	37,4

Figure 4: Tendency of quadriceps muscle temperature, between the experimental and control groups, during a professional football player match (Mohr et al., 2004).

Previously, in team games, some problems on maintaining muscle temperature, both during the gaming interval and for the players on the bench, have been highlighted. Figure 4 provides some concrete indications for maintaining muscle temperature at such a temperature that performance does not decay it; therefore it is necessary:

- To always practice, during the game pause (between the 1stand 2ndhalves), a muscular activation with localized contractions and exercises related to the technical movements of the sports discipline;
- For the players on the bench, to practice, where possible, a minimum muscle activation every 5 minutes, using analytical exercises with localized contractions;
- To use electro-stimulation for the vascularization of quadriceps, ischio-crural muscle group and triceps, so the players will minimize their muscle temperature drop and, at the same time, remain focused on actions during the game and on tactical indications provided by the coach.
- In addition, if a player is replaced, it is necessary to immediately cover them with appropriate garments that will slow the muscle temperature drop.

CONCLUSION

The choice of exercises must contribute to the achievement of a general objective such as warm-up, and several specific objectives such as increased vascularisation, central and peripheral temperature, preparation for contact and recall of the main technical qualities - tactics needed for the sports discipline. In team sports, it is important to do a good muscle activation so as not to adversely affect sports performance and to avoid injuries during training and the match.

Let us now summarize, in some simple methodological principles, some modalities to be realized or to avoid in order to obtain an optimal activation:

- The warm-up phase should be started with an activity that favours increased vascularization (avoid slow travel);
- Use explosive dynamic exercises and articular mobility exercises (oscillations), binding them to the technical movements of the sports discipline;
- Include specific technical movements with the use of a ball, after completing the phase of muscle temperature increase and articular mobility.

It should be remembered that muscle activation must be programmed and realized in such a way that it does not waste too much energy, as it will then be used in the final stages of the race. Knowing that the increase of temperature in the body and muscles represents an important factor for sports performance makes it essential to keep the temperature at an optimum level (about 39° C). Also, the psychological feedback, including the athlete's and their coach's comfort with warm-up routines for future use, should be evaluated alongside physiological measures in future studies. Finally, you should always use muscle heating in the interval between the two halves of the match and do not forget that the management of players on the bench is important for both the player who entered the match (it is desirable to use exercises with localized contractions, or the use of the electrostimulation) and for the replaced player, who must always be covered so as not to lower the muscle temperature too much.

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FIZIOLOŠKI EFEKTI ZAGRIJAVANJA I PROBLEMI VEZANI ZA TIMSKE SPORTOVE

U ovom radu, u obzir će se uzeti svi ciljevi i faktori vezani za fazu zagrijavanja, a koji mogu pozitivno uticati na izvedbu, te omogućiti svakom igraču dobru tjelovježbu ili utakmicu, bez obzira na njihov nivo takmičarski nivo. Rezultati nekoliko naučnih radova će nam omogućiti da bolje razumijemo, te preciznije motivišemo naše metodološke izbore i pažnju prilikom izvođenja procedura, uz poštivanje karakteristika timskih sportova. U ovom radu, istražiti ćemo efekte zagrijavanja u zavisnosti od različitih procedura, te na koji način oni utiču na sportsku izvedbu i prevenciju povreda zglobova i mišića. Nakon toga ćemo analizirati efekte koji mogu proizvesti dobro ili loše zagrijavanje, te koliko pauze tokom igre mogu uticati na temperaturu mišića u timskim sportovima. Na kraju ćemo provjeriti koje se procedure mogu koristiti kako bi se postigla opća efektivna aktivacija u svrhu sportske izvedbe.

Ključne riječi: Mišići, temperatura, pauze tokom igre, metodologija, vježbe, sportska izvedba.

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FEMORAL BIOMECHANICAL LENGTH AS A RISK FACTOR FOR ANTERIOR CRUCIATE LIGAMENT RUPTURES

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ABSTRACT

The difference between distal femoral morphometric parameters in genders has been proposed as an explanation for more frequent non-contact anterior cruciate ligament injuries in female athletes. We measured the femoral biomechanical length, epicondylar breadth width and 2 linear morphometric parameters of the femoral intercondylar notch and their indices to determine their correlation and to ascertain whether they can be used as risk factors for anterior cruciate ligament ruptures. Femoral biomechanical length correlates positively, but weakly with the linear morphometric parameters of the intercondylar notch and negatively with the intercondylar notch indices. The femoral biomechanical length as such, should be used with caution as a risk factor for anterior cruciate ligament ruptures.

Keywords: ACL, Femoral length, Intercondylar notch, Knee, Traumatology.

INTRODUCTION

Injuries of the anterior cruciate ligament (ACL) are often categorised as contact and non-contact injuries (Murray M, 2013). Non-contact injuries occur more often than contact injuries (Alentrorn-Geli E, et al., 2009; Murray M, 2013) which is explained with risk factors ranging from morphological and biomechanical to hormonal factors (Alentrorn-Geli E, et al., 2009; Gordon CM & LeBoff MS, 2015).

The main pathobiomechanic explanations for ACL injuries are knee hyperextension and external rotation during knee flexion which results in the loss of elastic potential and rupture of the ACL due to stretching over the medial femoral condyle (Gordon CM & LeBoff MS, 2015; Miller MD &Thompson SR, 2015). In recent studies it has been confirmed by methods of clinical, cadavers, in vitro and video analysis studies that the most non-contact ACL injuries occur during change of direction while decelerating, landing an extended or near extended knee or pivoting on a leg with a planted foot (Alentrorn-Geli E, et al., 2009).

Such events create the third, pathological, freedom of movement in the Z-axis resulting in positive clinical signs (Kapandji IA, 1972; Dutton M, 2012). Among the risk factors trying to explain the more frequent appearance of ACL injuries in female athletes are differences in distal femoral morphology, particularly the femoral intercondylar notch (Stiljak L, et al., 2012). It has been proposed that a deeper and narrower intercondylar notch exposes athletes to a higher risk of ACL injuries, particularly in female athletes (Shelbourne KD, et al., 2009). Although the explanation made morphological and biomechanical sense, the usage of distal femoral morphology difference as a risk factor for ACL injuries is largely debated and is scarcely used in everyday practice to explain the injury frequency of female athletes (Schickendantz MS & Weiker GG, 1993; Teitz CC, et al.,

1997). As such, multiple factors explain why caution is advised when examining risk factors for ACL injuries seeing that isolated conclusions might be questionable and further explanations are warranted. Morphological risk factors could be expanded by the femoral biomechanical length of the femur seeing that a positive correlation with the already established risk factors could result in a more comprehensive evaluation of athletes by partial or absolute leg length measurements and preventive actions.

MATERIALS AND METHODS

We examined 100 adult dry human femora, 52 of which were male and 48 female. The femora were taken from the Department of Anatomy, Faculty of Medicine, University of Sarajevo. Femora with visible pathological alterations were excluded from the study.

The Femoral Biomechanical Length (FBL) was defined as the mean of the distance between the inferiormost part of the femoral neck and the medial and lateral condyle. Two measurements were made and the mean was used as the FBL. Two intercondylar notch morphological parameters were measured, in accordance with Martin (1962) and White et al. (2012), using sliding callipers, the measurements were recorded in millimetres. The morphological parameters were Intercondylar notch width (ICW) and Intercondylar notch height (ICH). In addition to the two parameters we calculated their relevant indices; Notch Width index (NWI) and Notch Shape index (NSI). Notch Width Index was defined as the ratio of ICW and Epicondylar Breadth Width (EBW). Notch Shape Index was defined as the ratio of ICW and ICH. The recorded measures were then sorted by gender and statistical measures were applied.

We determined descriptive statistical measures, correlation methods and ascertained the difference between male and female femora with paired t-tests using the IBM SPSS and XLSTAT programme. We have taken values of p as $0.01<p<0.5$ as significant, $0.001<p<0.01$ as very significant, values $p<0.001$ were taken as highly significant. Values $0.5<p$ were taken as insignificant and a positive correlation (Pearson) was determined as $r\leq1$ while a verbal scale according to Evans (1996) was used with 0.00-0.19 marked as "very weak", 0.20-0.39 as "weak", 0.40-0.59 as "moderate", 0.60-0.79 as "strong" and 0.80-1 as "very strong".

RESULTS

The Femoral Biomechanical Length mean in both genders was 42.07±2.40mm with the maximum value amounting to 48.50mm and minimum value being 36.00mm. The male samples mean was 43.47±2.12mm with the maximum value of 48.50mm and the minimum value of 39.00mm. The female samples mean was 40.56±1.69mm with the maximum value of 43.50mm and minimum value of 36.00mm (Table 1). The difference between male and female samples was highly significant ($p\leq0.001$). The correlation coefficient between Femoral Biomechanical Length and Intercondylar Notch Width was 0.253, resulting in a weak positive correlation verbal score (Table 2, Figure 1). The correlation coefficient between Femoral Biomechanical Length and Intercondylar Notch Height was 0.312, also resulting in a weak positive correlation (Table 2, Figure 2). The Femoral Biomechanical Length correlated negatively with relevant intercondylar notch indices, -0.012 for Notch Width Index and –0.014 for Notch Shape Index. Intercondylar Notch Width mean for both genders was 18.71±3.82mm with the maximum value of 32mm and the minimum value of 10mm; the correlation coefficient was 0.006 which shows that the correlation between ICW and EBW is very weak (Table 1).

For male ICW values the mean was 19.32±4.25mm with the maximum value of 32mm and the minimum amounting to 10mm (Table 3). The correlation factor between male ICW and EBW values was -0.266, hence the negative correlation between male ICW and EBW values. Female ICW value mean was 18.04±3.40mm with the maximum value amounting to 25mm and minimum value being 10mm (Table 4). The correlation coefficient between female ICW and EBW values was -0.422, confirming that, just like their male counterpart, the female ICW correlate negatively with EBW values. The difference between male and female ICW value was significant ($p<0.5$) but with a noticeable overlap of values (10-35mm for male and 10-25mm for female femora).

The Intercondylar notch height value mean in both genders was 28.00±4.48mm with the maximum value of 40mm and the minimum amounting to 15mm (Table 1). The correlation coefficient between ICH and EBW for both genders was 0.087, resulting in a positive but poor correlation. The male ICH values mean was 29.05±5.58mm with the maximum value being 40mm and the minimum amounting to 15mm (Table 3). Male ICH and EBW values correlate negatively with the correlation coefficient of -0.23. Female ICH values mean was 26.85±4.12mm with the maximum value of 35mm and the minimum value amounting to 16mm (Table 4). Female ICH and EBW correlate negatively with the correlation coefficient of -0.144. The difference between male and female ICH values was significant ($p<0.05$) and with a major overlap (male values 15-40mm, female values 16-35mm). We calculated the NWI and NSI for both genders and subsequently for male and female femora. Notch Width Index mean for both genders was 0.24±0.05 with the maximum value of 0.40 and the minimum being 0.11. For male femora the NWI mean was 0.23±0.05 with the maximum value of 0.40 and the minimum amounting to 0.11.

The NWI mean for female femora was 0.25±0.05 with the maximum value of 0.38 and the minimum amounting to 0.13. The difference between male and female NWI indices was insignificant (p≥0.05). The Notch Shape Index mean was 0.68±0.19 with the maximum value of 1.66 and the minimum being 0.40. For male femora the NSI mean was 0.67±0.19; maximum 1.67 and minimum 0.43. For female femora the NSI mean was 0.69±0.19; maximum 1.25 and minimum 0.40. The difference between male and female femora was insignificant (p≥0.05).

DISCUSSION

The Femoral Biomechanical Length is defined as the mean of the distance between the inferiormost part of the femoral neck and the medial and lateral condyle (White TD, et al., 2012). This definition could be confused with other terms like Femoral length, Maximal Femoral length, Femoral Physiological length or Femoral Bicondylar length. Maximal Femoral length is defined as the maximum length that can be measured between the top of the femoral head and the bottom of the farthest condyle measured with an osteometric board (White TD, et al., 2012). Femoral Physiological (Bicondylar) length is measured by placing both condyles firmly against the stationary end of an osteometric board and, while keeping the shaft of the femur parallel to the surface of the board, measuring the distance to the furthest point on the femoral head. We chose the Femoral Biomechanical Length because it can be approximately, clinically measured using the major trochanter as a proximal reference point and the lateral and medial epicondyle or joint line as the distal reference points, providing possible practical importance in determining ACL rupture risks in athletes (Dutton M, 2012).

In this study we proved that the Femoral Biomechanical Length correlates positively with both the linear morphometric parameters, ICW and ICH and negatively with intercondylar notch indices, NWI and NSI. The positive correlation between FBL, ICW and ICH is weakly positive, throwing doubt over the possible deduction of ICW and ICH values from FBL measurements. These results do not correlate with the results from other similar studies. Stiljak et al. (2009) determined that the femoral length correlates moderately to strongly with distal femoral parameters including ICW and ICH among others. Our conclusions were, however, similar regarding the intercondylar notch indices. The difference could be due to different methodologies or terminologies regarding the femoral length.

They measured the femoral length as the distance between the uppermost and the lowermost point of the whole femur in contrast to our measurement methodology, respectively. The intercondylar notch indices show no difference between genders and as such cannot be used to determine the non- contact ACL injury frequency in female athletes, on top of the established negative correlation with the FBL. The value of linear intercondylar notch parameters as risk factors for ACL ruptures is still debated with some authors claiming that the parameters have legitimate value (Shelbourne KD, et al., 1979; Souryal TO & Freeman TR.; 1993; Anderson AF, et al., 2001; Stiljak L, et al., 2014), while others oppose the idea (Schickendantz MS & Weiker GG., 1993; Teitz CC, et al., 1997; Alentrorn-Geli E, et al., 2009; 10, 11].

The main rationalisation for using the aforementioned parameters were the presumption that the notch parameters correlate well with ACL thickness and that the shape of the notch affects the biomechanical properties of the ACL (Muneta T, et al., 1997; Norwood LA, Cross MJ, 1977; Tilman MD, et al., 2002). Anterior cruciate ligament thickness correlates poorly with intercondylar width as determined by Muneta et al. (1977). The importance of the intercondylar notch shape has multiple biomechanical explanations including possible impingement of the cruciate ligaments in the anterior portion of the intercondylar notch which is in this case narrower due to low NSI and the fact that the cruciate ligaments contact with the intercondylar roof when in full extension, arguing the importance of the intercondylar height (Norwood LA, Cross MJ, 1977, Tilman MD, et al., 2002). Such a mechanism could explain the more common injuries in people of European in contrast to African descent (Norwood LA, Cross MJ, 1977). Other authors have tried to explain the occurrence of ACL injuries using the Notch Area Index (NAI) and similar area based experiments like Tillman et al. (2002) used the Notch Area Index (NAI) to quantify the area of the intercondylar notch and to determine the difference between race and gender. They concluded that there are is no difference in NAI between race and gender. Houseworth et al. (1987) used radiographs to determine the area of the intercondylar notch rather than just the linear morphometric parameters in the previous studies. They determined that a lower posterior arch of the intercondylar notch might pose a risk for ACL injuries.

CONCLUSION

Femoral Biomechanical Length correlates positively with the linear intercondylar notch parameters and could be used as such to clinically or radiographically determine the risk for ACL rupture although with caution, seeing that the parameters correlate weakly. Negative correlation between Femoral Biomechanical Length and Intercondylar notch indices has been established.

Intercondylar Notch Indices cannot be used to explain the difference in ACL rupture frequency between genders due to the lack of difference between male and female femora. The usage of distal femoral parameters as risk factors for ACL rupture frequency remains controversial and is not widespread in both practice and literature.

Table 1: Descriptive statistics for the measured values with both genders included

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
FBL	100	0	100	36.000	48.500	42.078	2.400
ICW	100	0	100	10.000	32.000	18.300	3.794
ICH	100	0	100	19.000	40.000	27.630	4.273
EBW	100	0	100	62.000	91.000	77.360	6.354

Table 2: Correlation matrix between Femoral Biomechanical Length, Intercondylar Notch Width and Intercondylar Notch Height

Variables	FBL	ICW	ICH
FBL	1	0.253	0.321
ICW	0.253	1	0.355
ICH	0.321	0,355	1

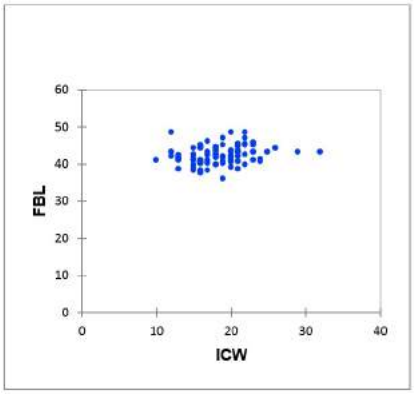

Figure 1: A scatter plot for the correlation between Femoral Biomechanical Length and Intercondylar Notch Width

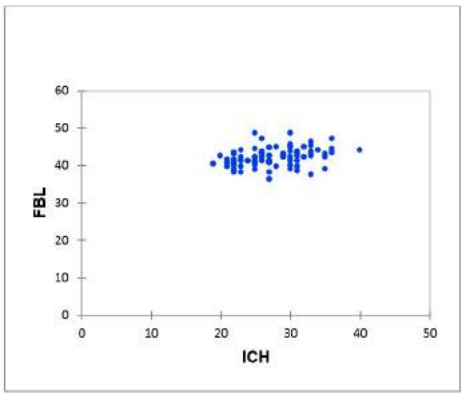

Figure 2: A scatter plot for the correlation between Femoral Biomechanical Length and Intercondylar Notch Height

Table 3: Descriptive statistics for male samples

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
FBL	51	0	51	39.000	48.500	43.495	2.137
ICW	51	0	51	10.000	32.000	19.255	4.083
ICH	51	0	51	20.000	40.000	29.059	4.086
EBW	51	0	51	76.000	91.000	82.216	4.163

Table 4: Descriptive statistics for female samples

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
FBL	48	0	48	36.000	43.500	40.563	1.659
ICW	48	0	48	10.000	24.000	17.292	3.248
ICH	48	0	48	19.000	35.000	26.000	3.892
EBW	48	0	48	62.000	80.000	72.083	3.451

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FEMORALNA BIOMEHANIČKA DUŽINA KAO RIZIKO FAKTOR ZA RUPTURE PREDNJEG KRIŽNOG LIGAMENTA

predložena kao objašnjenje za češće nekontakne povrede prednjeg križnog ligamenta kod žena sportistkinja. Izmjerili smo femoralnu biomehaničku dužinu, epikondilarnu širinu i dva linearna morfometrijska parametra interkondilarnog usjeka, te njihove indekse da bi ustanovili njihovu korelaciju i ustanovili da li se mogu koristiti kao riziko faktori za rupture prednjeg križnog ligamenta. Femoralna biomehanička dužina pozitivno ali slabo korelira sa linearnim morfometrijskim parametrima interkondilarnog usjeka, te negativno sa indeksima interkondilarnog usjeka. Femoralna biomehanička dužina se kao takva treba koristiti kao riziko faktor za rupture prednjeg križnog ligamenta sa oprezom.

Ključne riječi: ACL, Femoralna biomehanička dužina, Interkondilarni usjek, Koljeno, Traumatologija.

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THE EFFECT OF PILATES EXERCISE ON GLYCAEMIC CONTROL AND WEIGHT LOSS IN OBESE WOMEN WITH TYPE 2 DIABETES

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ABSTRACT

The purpose of this study was to evaluate the effect of Pilates exercise on glycaemic control and weight loss in obese women with type 2 diabetes. In a quasi-experimental study, 30 untrained obese women with type 2 diabetes, a mean age of 51.9 ± 5.9 years and a BMI above 30 were selected randomly and divided into two groups: control and experimental. Group practice Pilates exercises were held 3 times a week for two months and each session lasted 60 minutes, alongside the monitoring of the control group. Before and after the intervention, the weight, BMI, fasting blood glucose and HbA1 clevels were measured and the data were analysed using SPSS software and T-test. The results showed that after two months of Pilates exercises, patients in the exercise group had a significantly decreased fasting blood glucose level (p =0.012) and HbA1c (p=0.003) compared to the control group, but this reduction was not followed by a statistically significant weight and BMI decrease. Pilates exercise reduces fasting blood glucose and HbA1c in two months, but the changes in weight and BMI are not significant in these patients. It seems the Pilates exercises, with health care, can improve and control type 2 diabetes, the most common non-communicable chronic disease in the world.

Keywords: Pilates, type 2 diabetes, blood glycaemic control, obesity.

INTRODUCTION

The Incidence and prevalence of diabetes and obesity are increasing in the last century and the mortality from the epidemic has created big health problems for human beings (1). Type 2 diabetes is a chronic disease caused by genetic and environmental factors such as diet, family history, insulin resistance and a disorder in the beta-cell function (2). On the other hand, the prevalence of obesity and inappropriate lifestyle, sedentary and other factors are associated with it. Diabetes has several complications with the increasing of chronic hyperglycaemia being its long-term one (3) and hyperglycaemia or glucose intolerance and defects due to the stimulatory effect of insulin to use glucose are the best predictors of type 2 diabetes. It is well confirmed that high levels of glucose and glycosylated haemoglobin (HbA1c) go along with the increasing risk of cardiovascular diseases (4). HbA1c shows a small percent of haemoglobin which is irreversibly glycosylated (5). The most common test for the metabolic control measurements of glycosylated haemoglobin and the best goal of therapy in people with diabetes is regulating the glycosylated haemoglobin. Reducing HbA1c glycosylated haemoglobin levels benefits in reducing cardiovascular complications (6).

Nowadays, it is said that knowledge, controlling diabetes complications, diet, medication and physical activity are the basic principles of controlling diabetes, and that the low cost and non-pharmacological nature of physical activity increase the importance of health care (7). Some believe

that regular physical activity has an important role in managing type 2 diabetes, especially glycaemic control and cardiovascular risk factors modification, increasing insulin sensitivity, reducing body fat and blood pressure, and leads to a significant reduction in HbA1c and blood glucose, reduction of hyperlipidaemia and heart risk factors (3, 8). Also, physical activity causes weight loss and it leads to reduced levels of triglycerides and low-density lipoprotein, the elimination of extra fat and blood pressure regulation (6, 9).

Although physical activity is a recommended treatment for diabetes, there is little activity in these patients. Researchers have estimated that 37-60% of diabetic patients do not exercise, or don't follow the exercise schedule that health care workers have prescribed for them (10). Also, despite the fact that active lifestyle is one of the major determinants of health, regular physical activity was lower in women than men, and its amount also decreases with age. These low levels of activity lead to loss of muscle strength and flexibility, weight gain and obesity, disability, early mortality due to cardiovascular disease, insulin independent diabetes, cancer, and osteoporosis (11).

On the other hand, most people, due to various diseases such as diabetes and obesity, can participate in physical activity. In recent years, Pilates is one of the sports taken into account by sports and rehabilitation specialists and it becomes a general one (12). Pilates is a good way to practice mindfulness exercises, body and movement situation control, and it is between yoga and gymnastics technique practiced throughout world (13). Also, a complication from diabetes is considered in the clinical supports and public health management, since diabetes and the exacerbation of the disease is the concern of the patient (14). Therefore, the least-risk activities such as Pilates can be a good exercise for them. It is an exercise in static positions (lying, sitting and standing) done without walking, jumping and leaping over. The advantage of Pilates exercise is that doing these activities reduces the risk of joint and muscle damage and it is also applicable in any location (home, work, open and closed spaces ...) and for every stratum of the population, including the elderly (15,16).

The incidence of type 2 diabetes rises with the increasing factors such as obesity, dietary changes and decreased physical activity (6). Many studies have investigated the effects of aerobic exercise in these patients, and, in most cases, diabetes improvement in controlling glycaemic and lipid profile were reported (6, 17). Most of the research about Pilates were conducted on healthy persons or non-diabetic patients (18-20). For example, Jago et al. evaluated the effect of 4 weeks-long Pilates on body composition in young girls, and found that Pilates reduces BMI and obesity in girls (21). In a study, Hashemi et al. investigated the effect of 8 weeks-long Pilates on cortisol and fat indexes in 20 obese women and found that Pilates reduces weight, BMI, cholesterol, LDL, and increases cortisol (22). In another study, the role of Pilates and water sports on health and fitness in 25 women, 75-55 years old, were investigated. Divided into two groups, the subjects exercised and practiced water sports once a week, with Pilates exercises lasting an hour and half, for the period of 10 weeks. The results showed that, although exercising once a week has positive effects on these people, it is not enough (19).

Whereas Pilates, practiced for 8 weeks, in sedentary and overweight people decreases the waist-to-hip ratio, body fat percentage and basal metabolic rate significantly (20). According to the previously mentioned, despite of the importance of controlling blood glucoseand weight loss in obese patients with type 2 diabetes, there is little awareness about the effects of Pilates and, in studies about the Pilates effect on these variables in diabetic patients, the research on diabetes in samples of this age did not find it. However, little research was done on obese diabetic subjects, but with few of them, and they were not focused on checking the control of blood glucoseand weight loss in these patients. Pilates was not used in the research. On the other hand, the effects of obesity on insulin resistance are acceptable. Also, physical activity is accounted as an important determinant of weight and several studies reported that it has a great effect on reducing the risk of overweight and obesity in women. Considering the impact of physical activity on both diabetes and obesity, a question of whether doing Pilates during two months has an effect on blood glucosecontrol and weight loss in obese women with type 2 diabetes arises.

PARTICIPANTS

This quasi-experimental study was conducted in Iran. The research has an interventionist nature of pre-test and post-test. The statistical population consists of obese women with type 2 diabetes (fasting blood glucosegreater than 125 mg per decilitre) with a BMI > 30. 87 volunteers participated in the study, out of which 30 patients with a mean age of 51.9 + 5.9 years and, according to the conditions of the study (people who have no other diseases but type 2 diabetes, those who do not smoke, have had a lack of regular physical activity during the past year, BMI > 30, with fasting blood glucosegreater than 25 milligrams per decilitre, aged 40-60 years old and during menopause, with a lack of insulin and the ability to participate in the Protocol for 2 months) were selected randomly for the sample.

INSTRUMENTS AND PROCEDURE

At the beginning of the meeting, the participants in the project were familiarised with the plan, objectives and methodology. Participants were assured that their

information will remain completely confidential and will be used to evaluate data encryption. It also allowed them to feel free to leave the study. Also, in this meeting, those who wished to participate in the project completed a questionnaire related to their own medical history and were introduced to clinics and clubs for medical examination and exercise. Subjects were randomized into two equal groups; Pilates (n = 15) and control (n = 15) groups.

The Pilates group exercised for two months, 3 times a week and each session lasted sixty minutes, alongside the monitoring of the control group. For patients in the exercise group, basic principles of Pilates were described in the first session, and general information regarding Pilates was given to them. At the beginning of each session, breath control and proper standing positions in Pilates classes were taught. Then, the respondents did stretching exercises (for about 5 minutes), followed by Pilates exercises (for about 50 minutes), cool down and reversing to the initial status (for about 5 minutes).

In order to meet the main overweight, repetitions of each session were increased in comparison with the previous one, so that 10 repetitions were done in the first and 50 to 60 in the last sessions. Home run movements in Pilates class consisted of stretching the leg to the side and repeating it (10 reps), the cradle position (10 reps), pulling the leg back (15-20 reps), the cat movement (15-20 reps), half sit-ups (25-30 reps), spine rotation (50-60 reps), full sit-ups (50-60 reps) and the circular motion of the legs (50-60 reps) (22). The researcher presented each exercise and then displayed the word with the help of one of the patients.

To ensure the accuracy of learning, exercises were repeated and, during their performance, patients were monitored and given the necessary instructions. In order to enhance coordination and facilitate the learning process, all movements were taught to the patients in a slow and controlled manner.

Training started from a lower difficulty level and gradually progressed until subjects were able to withstand the exercise. The exercises followed from a lying position to sitting and standing. The subjects have been told to increase the speed of exercising until they felt discomfort. Glucoseand blood pressure during all practice sessions and the possible incidents were controlled by a nurse.

Also, variables such as age, duration of disease, weight and BMI were measured for all participants. The subjects' height was measured with a tape measure. Then, Beurer (Germany) digital weighing scales, with a sensitivity of 100 g per kg, were used so that the subjects' weight (with minimal clothing and without shoes) was recorded and used to calculate the Body Mass Index. For each subject, the Body Mass Index was calculated as the ratio of weight (in kilograms) divided by the height squared (in meters). Blood samples (in the case of overnight fasting) were measured before and after the intervention. After blood sampling, the fasting blood glucose and HbA1c were also measured using HPLC, column chromatography kit (made in French) and HbA1c laboratory analyser DS5 models (made in Germany). In pre-test, subjects were asked to note the amounts and type of food consumed in the past 24 hours in the questionnaires and, after the last training session and on the day after the blood samples test, they have a similar diet.

STATISTICAL ANALYSIS

In the present research, data is processed using SPSS version 18. To show the measure of central tendency and dispersion, descriptive statistics were used. Normal distribution was studied using the Kolmogorov-Smironov test.

After ensuring that the groups were natural and homogenous, an independent T-test was used to evaluate intra-group changes from the pre-test to the post-test and the differences between the two groups. In all the statistical processes, the significance level of $p < 0.05$ was noted.

RESULTS

Descriptive information about the age, weight, BMI and subjects' duration of disease is shown in Table 1. Statistical analytical results about FBS, HbAlc, weight and BMI are shown in Table 2. Statistical test results showed that there is a statistically significant difference in FBS (p=0.012) and HbAlc (p=0.003) variables in the exercising group before and after the test. These results also revealed that FBS decreased 10.3 % in the exercising group, but no changes in the control group were seen. HbAlc had significant changes via decreasing 13.2%, but there was not any change in the control group.

Table 1: The subjects' characteristics

Pilates Group	Control Group	Variable
51.06±2.3	51.2±3.7	Age (year)
73.77±9.78	74.61±11.57	Weight (Kg)
30.04±0.9	31.73±1.02	BMI (kg/cm2)
6.52±2.66	6.77±2.9	Disease duration (Year)

Table 2: Results of statistical analysis of the variables between groups - *Significant and meaningful level of 0.05 is intended.

P value	t	Posttest	Pretest	Group	Variable
0.012*	3.48	145.32±53.28	161.35±64.62	Pilates	Fasting blood glucose (mg/dl)
0.167	-1.8	155.87±52.11	153.05±18.48	Control	
0.003*	3.03	6.81±0.93	8.75±1.62	Pilates	HbA1c (%)
0.254	-0.52	7.98±0.29	8.32±1.94	Control	
2.36	0.253	69.70±3.01	73.77±9.78	Pilates	Weight (kg)
-0.22	0.142	75.22±9.25	74.61±11.57	Control	
2.96	0.062	28.98±1.01	30.04±0.9	Pilates	BMI (kg/cm2)
1	0.172	31.90±1.71	31.73±1.02	Control	

Also, there is a significant difference in FBS and HbAlc between the two groups after two months of Pilates, but no significant difference in weight and BMI between the averages of two the groups is seen.

The results from the statistical analytical data of weight and BMI showed that, despite of a decrease in these amounts in the exercising group, this is statistically not significant and there is not any difference between the two groups.

DISCUSSION

The results showed that there was a significant reduction of fasting blood glucose(FBS) and HbA1c in the exercising group, but there is not any significant change in weight and BMI for this group. One of the noticeable results of sporting activities, confirming useful effects for type 2 diabetes patients, is the reduction of FBS and HbA1c having a significant decrease in this research.

In another research, Ebrahimi et al. (2015) have found that the selected Pilates exercises, during 3 sessions in 8 weeks, caused significant reduction of HbA1c in women 30-45 years old with type 2 diabetes (23). Sigal et al. (2007) showedthat 22 weeks of aerobic exercise, with 3 sessions per week, reduced bloodglucosein women with type 2 diabetes (24). Shamsi et al. (2010) have also observed that performing walking exercises for 3 months decreased HbA1c and blood glucose significantly in these patients (25). In justification of the Pilates effectiveness on the reduction of FBS and HbA1c, it can be said that physical activities, especially dynamic, strong exercises, reduce insulin sensitiveness, fasting glucose, insulin resistance and finally decrease glucose levels, especially in women. As Pilates is a resistive exercise, its resistance is applied in the form of body weight and the main extra weight is added by increasing the progression of repetitions. Consequently, according to the principle of Pilates, since glycated haemoglobin is produced during the life of the red blood cells (RBC) and its amount directly depends on the density of blood glucose, skeletal muscles can be more affected by these exercises (23). Exercise increases glucose in body muscles, and this change depends on functional changes in insulin signals, while also being related to the increase of GLUT.4 protein ingredients (26).

Also, studies showedthat consuming energy levels increase due to deep and diaphragmatic breathing in Pilates exercises, because, in addition to active muscles, respiratory muscles consume more energy (27). On the other hand, deep and diaphragmatic breathing is used because the oxygen reaches the body easier and insulin sensitiveness increases, which then leads to a decrease in the levels of glucose(9). Therefore, the reduction of glucoseand HbA1c levels in this study can be partly attributed to the mentioned reasons.

On the other hand, significant changes in weight and BMI were not observed. Hamedinia et al. (2012) have found that everyday exercises for 5 weeks and those performed every other day for 10 weeks have no significant effect on the weight and BMI of women with type 2 diabetes; they know that the short period of exercise is a possible reason for the results (28). Also, Jorge et al. did not see any significant changes in BMI after 12 weeks of aerobic exercise. In this study, the subjects were 30 – 70 years old, having a BMI of 25 - 40 and researchers pointed out the subjects' wide range of ages and a high amount of BMI as possible reasons for the lack of significant results (29). Whereas, Oberbach et al. (2006) have reported that there is significant reduction in the patients' BMI and weight after 3 weeks

of aerobic exercises (cycling and running along with strength exercise for 60 minutes in each session for 3 sessions per week) (30).

Generally, the difference in the kind, term and amount of exercises and in some of them, exercise and diet simultaneously, can be the possible reason for the nonexistence of a significant effect of Pilates on weight and BMI in this study, in comparison with other studies. In several studies, researchers have observed that the lack weight or fat decrease due to aerobic exercises may be related to the increase of receiving energy, the reduction of consuming energy or both of them (28). Like the results of this study, in most studies, despite the decrease in body fat, no significant changes were observed, which is, perhaps, because of the reduction in fat and muscle tissue, as well as tissues having no fat in sports groups (6, 29). To approve of this issue, Kadoglou et al. have shown that exercise without losing weight leads to a decrease in controlling glycaemia in patients having type 2 diabetes (31). As the study of the subjects' nutrition was conducted only in the pre-test and post-test, the lack of controlling the subjects' nutrition during the period of exercise may be regarded as one of the shortcomings of this study.

CONCLUSION

The results showed that two months-long Pilates exercise decreases the fasting blood glucose and HbAlc in obese women with type 2 diabetes, but significant changes in weight and BMI of these patients were not observed. Perhaps this defect can be removed by changing the duration and intensity of exercise alongside a diet regime. Finally, it can be said that in future research, more accurate research will be done in morphological and anthropometric subjects via taking into account factors such as nutrition, duration and intensity of exercise, in addition to physiological changes.

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EFEKAT PILATES VJEŽBI NA GLIHEMIJSKU KONTROLU I MRŠAVLJENJE KOD PRETILIH ŽENA SA DIJABETESOM TIPA 2

Svrha ovog istraživanja je procjena efekta Pilates vježbi na glihemijsku kontrolu i mršavljenje kod žena sa dijabetesom tipa 2. U kvazieksperimentalnom istraživanju, 30 neobučenih, pretilih žena, sa dijabetesom tipa 2 i prosječnim brojem godina 51.9 ± 5.9 godina, te indeksom tjelesne mase (BMI) iznad 30, je nasumično podijeljeno u dvije grupe: kontrolnu i eksperimentalnu. Grupne Pilates vježbe su održavane 3 puta sedmično u periodu od dva mjeseca, sa trajanjem od 60 minuta po treningu, uz praćenje kontrolne grupe. Prije i poslije intervencije, težina, BMI, nivo glukoze u krvi natašte i HbA1c nivo su mjereni, te podaci analizirani koristeći program SPSS i T-test. Rezultati su pokazali da, nakon dva mjeseca Pilates vježbi, pacijenti u grupi koja je vježbala imaju značajno umanjen nivo glukoze u krvi natašte (p =0.012) i nivo HbA1c (p=0.003) u odnosu na kontrolnu grupu, ali ovo smanjenje nije praćeno statistički značajnim mršavljenjem i smanjenjem indeksa tjelesne mase. Pilates vježbe smanjuju nivo glukoze u krvi natašte i nivo HbA1c, ali promjene u smislu težine i BMI-ja nisu značajne kod ovih pacijenata. Čini se da Pilates vježbe, uz zdravstvenu njegu, mogu poboljšati i kontrolisati dijabetes tipa 2 koji je najčešća nezarazna hronična bolest u svijetu.

Ključne riječi: Pilates, dijabetes tipa 2, kontrola nivoa glukoze (glihemije) u krvi, pretilost.

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THE EFFECT OF COMBINED CARBOHYDRATE-CAFFEINE MOUTH RINSE ON ANAEROBIC POWER IN A REDUCED GLYCOGEN STATE

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ABSTRACT

The benefits of carbohydrate mouth rinsing, with and without caffeine, on anaerobic capacity during sprint cycling under glycogen reduced conditions were examined in this paper. In a counterbalanced double-blind design, nine futsal male players (age 21.7 ± 0.7 years, weight 70.3 ± 10.2 kg, height 176.3 ± 7.1 cm) completed a familiarization and three mouth-rinse trials: rinsing (10 seconds) and expectorating a bolus of 25 ml of either a carbohydrate solution (7.5% sucrose) (CHO), carbohydrate and caffeine solution (7.5% sucrose and 1% caffeine) (C-CAF), or a flavour matched placebo (PLA), followed by 30 seconds Wingate test (Brake Weight 7.5%). Experimental trials were performed in the morning, following a high-intensity running to volitional exhaustion in the prior evening and an overnight fasting. The main effect of mouth rinse on peak power ($p = 0.014$) and average power ($p = 0.015$) detected with PLA was significantly lower than the one found in CHO ($p < 0.05$) and C-CAF ($p < 0.05$). Minimum power and fatigue index were not significantly different between treatments. Power output during the first 5 seconds of the test was significantly higher in CHO compared with PLA ($p = 0.015$). Carbohydrate mouth rinse improves anaerobic performance in a reduced glycogen condition without any beneficial effects for the added caffeine.

Keywords: Carbohydrate Rinse, Caffeine Rinse, Wingate, Anaerobic Capacity.

INTRODUCTION

Training induced adaptations are potentially enhanced during an exercise performed under conditions of fasting and reduced glycogen stores, (Lane et al., 2015; Impeyet et al., 2016). Moreover, it is not uncommon for some athletes to exercise with reduced glycogen stores (Kasper et al., 2016; Kizzi et al., 2016) in order to enhance training induced adaptations such as improved fat and carbohydrate utilization and exercise capacity (Vicente-Salar et al., 2015). Recent evidence shows that short duration high intensity training can induce responses and adaptations similar to long duration low intensity training in the form of enhanced peak oxygen uptake and mitochondrial activity (Cochran et al., 2014; Skelly et al., 2014). However, high intensity training is negatively affected by reduced glycogen stores. Langfort et al. (1997) reported an 8 % drop in mean power output during a Wingate test following a 3 days long low carbohydrate diet, in comparison with a normal carbohydrate diet. The potential of improving exercise performance following a carbohydrate ingestion (Howald and Decombaz, 1983; Lee et al., 2017) and/or caffeine ingestion (Rosenbloom and

Sutton, 1985; Glaister et al., 2016) has been long known. However, substance ingestion might not be favoured by athletes looking to benefit from enhanced training adaptations, augmented by low carbohydrate availability (Vicente-Salar et al., 2015), and/or to avoid Gastrointestinal (GI) problems (de Oliveira E and Burini, 2014).

Recently, cumulative evidence from observational studies suggests that a similar beneficial effect to carbohydrate and/or caffeine ingestion could be obtained via carbohydrate mouth rinsing (Kasper et al., 2016), or caffeine mouth rinsing (Kizzi et al., 2016), especially in a fasting state (Kasper et al., 2016; Ataide-Silva et al., 2016; Kizzi et al., 2016). First reported by Carter et al. (2004), these authors observed a 2.9% improvement in performance during an hour of cycling after carbohydrate mouth rinse, in comparison to using a placebo. Furthermore, Kizzi et al. (2016) reported an improved power output during repeated sprint cycling in participants with reduced glycogen status following mouth rinsing with a caffeine solution, in comparison to placebo. The beneficial effect for carbohydrate or caffeine mouth rinses has been suggested to be due to the central effect (central nervous system activation), rather than a metabolic effect (Carter et al., 2004; Chambers et al., 2009). It is suggested that the presence of carbohydrate or caffeine in the mouth might affect brain activity (Chambers et al., 2009) and motor output (Turner et al., 2014), without inducing changes in circulating glucose levels (Gant et al., 2010; Lane et al., 2013) or plasma caffeine (Doering et al., 2014). Evidence suggests that the activation of oral receptors via carbohydrate or caffeine mouth rinses improves central drive and motivation, resulting in improved physical performance (Chambers et al., 2009). There is strong evidence from published data supporting the benefits of carbohydrate or caffeine mouth rinses on physical performance. However, to the best of our knowledge, there is no published study that addressed the effects of mouth rinsing with a combination of carbohydrate and caffeine solution on anaerobic capacity, during an anaerobic Wingate test. This study objective was to determine the effectiveness of carbohydrate mouth rinse in enhancing anaerobic capacity in a group of futsal players, and to determine any additive effects for adding caffeine to the rinsing solution. The hypothesis is that carbohydrate mouth rinse would improve power output in a fasted glycogen depleted state.

METHODS

PARTICIPANTS

Twelve futsal players (aged 21 to 23 years) participated in the current study. Inclusion criteria for this study included a clear medical history, no suffering from injuries, no special diet (e.g. weight reduction), non-smokers, at least 4 to 5 days per week of continuous training and/or participation in competitions, and a habitual caffeine intake of 100 mg per day or lower. Before the commencement of the study, participants were informed about the risks and benefits of the study and an IRB approved informed consent was obtained. This study was performed in compliance with the declaration of Helsinki.

The study was conducted at the Human Performance Laboratory at Hashemite University following the approval obtained from the Institutional Ethics Committee. Anthropometrics and body composition were determined.

Participants then underwent an incremental cycle test and maximal power output was determined. Participants also practiced the anaerobic sprint test (Wingate) used in the study. Three participants were dropped from the current study due to not being able to adhere to the study protocol. Therefore, a total of 9 individuals completed the study and their data were used for the analysis.

STUDY DESIGN

This study was a randomized, double blind, counter-balanced, and crossover trial. Participants visited the laboratory on four occasions. On the first visit, participants' anthropometrics were obtained, followed by familiarization with the study protocol and an incremental cycle test to assess maximal power output. Participants then attended three treatment testing sessions under glycogen reduced state with 4 days of recovery between testing sessions. All participants were instructed not to ingest caffeine for a period of 48 hours prior to each testing trial (Kizzi et al., 2016); they were trained to avoid potential caffeine sources such as tea, coffee, chocolate, and caffeinated drinks (e.g. cola, sport drinks, pre-workout drinks).

They were also instructed not to perform vigorous physical activity for 24 hours prior to testing sessions. Participants were asked to attend all testing trials in the morning following an overnight fast; they were also encouraged to bring their own water, only to be consumed after the conclusion of the testing trial. Upon their arrival, participants marked a visual analogue scale (100 mm) assessing their readiness for physical exercise.

Afterwards, they did stretching exercises of their choice for 5 minutes, followed by a 5 minute warm-up on a cycle ergometer at 100 W. Following the warm up, the participants were randomly assigned, in a counterbalanced manner, to one of the three mouth rinsing treatments. Rinsing included a bolus (25 ml) of either: (1) an artificially flavoured placebo (PLA), or, (2) a taste matched sucrose and caffeine solution composed of 7.5% sucrose and 1 % anhydrous caffeine (250 mg

of caffeine corresponding to 3 mg/kg) (C-CAF), or, (3) a 7.5 % sucrose solution (CHO). Participants rinsed each solution for 10 seconds before expectorating, and no ingestion of any of the trial solutions was determined after measuring the expectorated solution volume. One minute after the mouth rinsing, participants performed an anaerobic capacity sprint test (Wingate).

ANTHROPOMETRICS AND BODY COMPOSITION

Weight, measured to the nearest 0.1 kg, and body composition were assessed using InBody (Biospace, Seoul, South Korea), and height, measured to the nearest 0.1 cm, using a stadiometer (SECA, Hamburg, Germany). Body mass index (BMI) was calculated, the weight (kg) divided by the height squared (m2), with the participants wearing light weight training outfits, and no shoes.

INCREMENTAL TEST

To assess maximal power output (W_{max}), all participants performed an incremental test, using a cycle ergometer (Ergoline, Germany). The test consisted of a 5 minute rest, then a 5 minute warm-up at 100 W, followed by increments in work load of 25 W every minute, until voluntary exhaustion, or failing to maintain the required work load. W_{max} was determined as the highest power output reached during the last stage.

ANAEROBIC CAPACITY TEST

Wingate anaerobic capacity sprint test was performed by all participants during each of the three testing trials using cycle ergometer and software (Monark 894E, Sweden), with resistive load, set at 7.5 % of individual body weight. Cadence was recorded over 6 intervals (5 seconds each) and power output calculated from friction load and flywheel velocity.

Participants were instructed and encouraged to pedal as fast as possible before the application of the workload, and to sprint at an all-out effort for the entire period of the test (30 seconds). The highest and lowest interval values were used to determine peak power (W/kg), minimum power (W/kg) and to calculate fatigue index (%), while the sum of all intervals was used to calculate anaerobic capacity (kJ) as previously described (Mündel et al., 2017).

GLYCOGEN LOWERING PROTOCOL AND DIETARY INTAKE

Prior to the day of each testing trial, participants reported to the laboratory between 17.00 and 19.00 hours. They then performed a glycogen reducing protocol for 90 minutes, as previously described (Kizzi et al., 2016). It was followed by ingesting a low carbohydrate standardized meal.

Dietary records were obtained from all participants the week before the start of testing trials, the day before, and on the day of each testing trial. On the day prior to each testing trial, participants were asked to follow a similar dietary pattern to what was previously reported in their food records, however, their last meal (i.e. dinner between 20.00 and 21.00 hours) was replaced by ingesting a standardized 400 ml of a low carbohydrate liquid meal composed of: 4 Kcal (16.7 kJ) per kg body weight, 1 % CHO, 5 % fat, and 10 % protein. Adherence to the study required dietary protocol was determined through an analysis of obtained dietary records.

Participants received both training and written instructions on how to accurately weigh and record the consumed food and fluid quantity, describe the preparation method, meal frequency and type, the perceived mood, and intake time of all consumed food and fluids. The nutrition analysis software NUTRITIONEST PRO (Axxya Systems; Stafford, TX, USA) and Middle East food composition tables (http://www.fao.org/infoods/infoods/tables-and-databases/middle-east/en/) were used to analyse and estimate energy and fluids intake.

STATISTICAL ANALYSIS

All results are presented as mean ± standard deviation (SD). Normality of data distribution was confirmed by the Shapiro-Wilk test. Data were analysed using IBM SPSS statistics 23 (IBM SPSS, Chicago, USA). The effects of mouth rinsing treatments on performance and physiological variables were analysed using a 3 x 3 repeated measures ANOVA (session x treatment), followed by Bonferroni post hoc test for pairwise comparisons when needed.

The effect size measure partial eta squared (pn^2) was used to determine the magnitude of variance attributable to independent factors and interaction. The level of significance was set at $p < 0.05$.

METHODS

PARTICIPANTS

Table 1 describes the participants' baseline characteristics. Three participants were excluded from this study due to a lack of adherence to the study protocol, thus a total of nine individuals completed the study. None of the participants experienced any injuries or adverse medical events from participation in the study.

Seeing as caffeine affects humans' alertness and awareness, we recorded our participants' observations of their trial solutions, the majority of participants (7 out of 9) did not correctly identify trial solutions, suggesting that this was not a significant factor in the current results.

Table 1: Baseline characteristics of the study participants (n = 9).

Variable	Mean (SD)
Age (years)	21.7 ±0.7
Weight (kg)	70.3 ±10.2
Height (cm)	176.3 ±7.1
BMI (kg/m2)	22.6 ±3.0
Body fat percentage (%)	13.9 ±4.4
Fat free mass (kg)	60.1 ±7.0
Energy intake (Kcal/day)	2446.8 ±165.7
Maximal power output (W)	169.4 ±11.0

PERFORMANCE

The effects of treatments on the power output profile are presented in Table 2. A two-way repeated measures analysis revealed a significant main effect for treatment on peak power ($F (2, 12) = 6.225$, $p = 0.014$, $pn^2 = 0.509$), with PLA significantly lower than CHO (-1.06 W/kg, 95% CI: -1.88, -0.24) $p = 0.017$, and C-CAF (-0.50 W/kg, 95% CI: -0.94, -0.07) $p = 0.028$. CHO and C-CAF were not different from each other ($p = 0.138$). No trial order effect was detected on peak power ($p > 0.05$). Moreover, the mean power was significantly affected by the treatment ($F (2, 12) = 6.099$, $p = 0.015$, $pn^2 = 0.504$), with PLA being significantly lower than CHO (-0.56 W/kg, 95% CI: -1.05, -0.07) $p = 0.036$, and C-CAF (-0.53 W/kg, 95% CI: -1.01, -0.04) $p = 0.029$. CHO and C-CAF were not different ($p = 0.726$). No effect for trial order was detected on mean power ($p > 0.05$). The minimum power and power drop were not significantly affected by the treatment ($p > 0.05$) and/or trial order ($p > 0.05$).

Table 2: Power profile during the Wingate test in the PLA, C-CAF, and CHO experimental trials (n=9).
Note.[a] Significantly different versus PLA ($p < 0.05$).

Trial	Peak Power	Mean Power	Minimum Power	Power Drop
PLA	9.4 ±1.3	6.8 ±0.9	3.8 ±0.7	5.6 ±1.3
C-CAF	9.9 ± 0.8a	7.3 ± 0.6a	4.3 ±0.5	5.6 ±0.7
CHO	10.4 ± 0.7a	7.4 ± 0.4a	4.2 ±0.5	6.2 ±0.8
P value	0.014	0.015	0.224	0.220
pn^2	0.509	0.504	0.232	0.223
F value	6.225	6.099	1.813	1.723

During the Wingate test (Figure 1), repeated measures analysis revealed a significant main effect for treatment on power output during the first 5 seconds of the test ($F (2, 12) = 20.620$, $p < 0.0001$, $pn^2 = 0.775$), with CHO trial significantly higher than PLA (mean difference: -0.85 W/kg, 95% CI: -1.49, -0.22) $p = 0.015$, but not C-CAF ($p > 0.05$), whilst C-CAF and PLA were not significantly different ($p > 0.05$). No trial order effect was detected ($p > 0.05$).

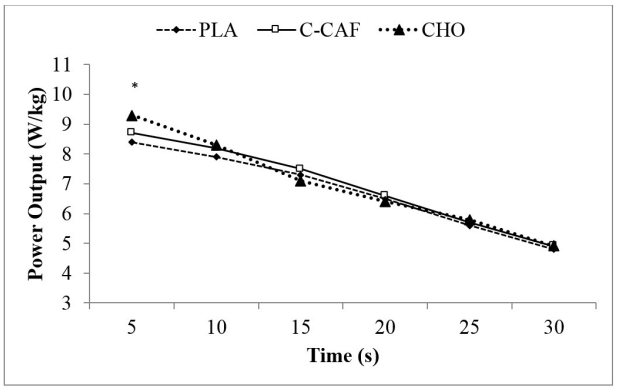

Figure 1: Relative power output during the Wingate test averaged over 6 intervals (5 seconds each) for the PLA - Placebo, C-CAF - Carbohydrate and Caffeine, and CHO - Carbohydrate experimental trials. Note.* significant main effect for treatment ($p < 0.05$). Values are mean ± SD, (n = 9).

The effects of treatments on anaerobic fatigue index are presented in Figure 2.

Although the fatigue index was slightly lower in the C-CAF trial (57.0 ± 5.9 %), in comparison with CHO (59.8 ± 5.2 %; $p = 0.332$) and PLA (59.5 ± 7.4 %; $p = 0.471$), no main effect for treatments on fatigue index was detected $F (2, 12) = 0.532$, $p = 0.600$, $pn^2 = 0.082$. And no trial order effect was detected ($p > 0.05$).

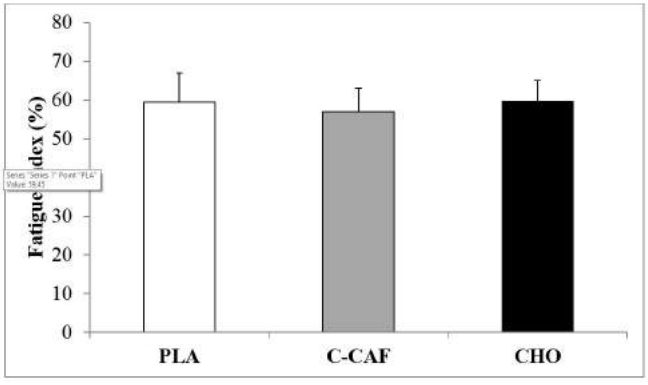

Figure 2: Anaerobic fatigue rate during the Wingate test in the PLA - Placebo, C-CAF - Carbohydrate and Caffeine, and CHO - Carbohydrate experimental trials.
Values are mean ± SD, (n = 9).

Figure 3 describes the effects of treatments on anaerobic capacity. There was no main effect for treatment on anaerobic capacity F (2, 12) = 2.509, p = 0.113, pn^2 = 0.239. Anaerobic capacity tended to be lower in PLA (13.9 ± 3.2 KJ), in comparison with CHO (14.6 ± 2.3 KJ; p = 0.179) and C-CAF (14.7 ± 2.6 KJ; p = 0.083). No trial order effect was observed (p > 0.05).

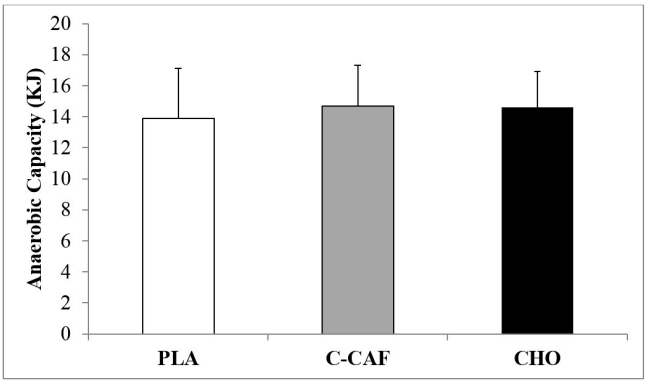

Figure 3: Anaerobic capacity (KJ) during the Wingate test in the PLA - Placebo, C-CAF - Carbohydrate and Caffeine, and CHO - Carbohydrate experimental trials. Values are mean ± SD, (n = 9).

DISCUSSION

This study investigated the effects of mouth rinsing with a PLA, C-CAF, or CHO solutions on power output during a 30-second anaerobic Wingate test, in futsal players under reduced glycogen state. The main finding of the present study was that mouth rinsing with either a 25-ml bolus of 7.5% sucrose solution (CHO), or a combination of 7.5% sucrose and 1 % anhydrous caffeine solution (C-CAF) for 10 seconds, immediately before performing the anaerobic Wingate test, significantly improved peak power output and mean power output compared to placebo (PLA).

The current results showed 8 to 9 % improvement in mean power output during the C-CAF and CHO trials, which is comparable to the previously reported improvements ranging between 3 to 12 % (Chambers et al., 2009; Pottier et al., 2010; Rollo et al., 2011; Sinclair et al., 2014). The variation in performance improvement could be a consequence of the differences in testing modality and intensity, as it has been previously suggested (Rollo et al., 2011).

The current results are in line with the previously reported findings that addressed the ergogenic effect of CHO mouth rinsing on high intensity exercise performance, (Carter et al., 2004; Whitham and McKinney, 2007; Pottier et al., 2010; Rollo et al., 2010; Rollo et al., 2011; Beaven et al., 2013; Sinclair et al., 2014; Rollo et al., 2015; Ataide-Silva et al., 2016; Fraga et al., 2017). Furthermore, Beaven et al. (2013) observed that, when compared to placebo, carbohydrate mouth rinsing or a combined carbohydrate and caffeine mouth rinsing improved peak and mean cycling power output during sprint one, of a repeated sprint test. These authors also observed an additive effect for caffeine when added to carbohydrate mouth rinsing in further augmenting power output. The authors suggested a central mechanism that enhanced motor unit recruitment to explain their findings. Although our results partially agreed with Beaven et al. (2013) in observing the improved peak and mean power output, following carbohydrate mouth rinsing or carbohydrate and caffeine mouth rinsing, no additive caffeine effect was observed in the current study.

This difference could be attributed to the effect of glycogen depletion in the current study. As motor unit recruitment may lead to a rapid depletion of ATP (Kasper et al., 2016), the reduced glycogen state will hinder proper motor unit reserve recruitment (Kasper et al., 2016). In support of current findings, Clarke et al. (2015) observed that the addition of 300 mg caffeine (comparable to the caffeine dose in the current study) to a 6 % carbohydrate mouth rinsing solution did not improve one repetition maximum (1RM) in Bench Press exercise, when compared to carbohydrate per se, indicating that a combination of caffeine-carbohydrate solution did not provide additional benefits to sustain anaerobic performance lasting for less than 30 seconds.

In this study, as we tested the maximal anaerobic exercise output, we did not collect data on Respiratory Exchange Ratio (RER) or Rating of Perceived Exertion (RPE). Nevertheless, many previous studies reported that RER and RPE values were not affected by carbohydrate mouth rinsing compared to placebo at any given intensity (Rollo et al., 2011; Ataide-Silva et al., 2016). Consequently, the potential mechanism by which carbohydrate mouth rinse improved performance in the current study is unlikely to be due to altered metabolism (Carter et al., 2004). To our knowledge, no previous studies have observed any alterations in blood glucose or blood lactate concentrations following a carbohydrate mouth rinse (Rollo et al., 2011).

Moreover, the lack of a conclusive metabolic explanation for the improved performance following a carbohydrate mouth rinse have led some authors to hypothesize that improvements are induced by central factors (Carter et al., 2004; Chambers et al., 2009). Indeed, carbohydrate mouth rinsing has been linked to the activation of reward regions in the brain (Chambers et al., 2009), improved corticomotor pathway output (Gant et al., 2010) and an increased activation within the primary sensorimotor cortex (Turner et al., 2014); altogether, such changes in the motor cortex output have been previously proposed to improve performance and

delay fatigue (Ross et al., 2007). Although it is not supported by a conclusive evidence, a "Central Effect" could provide a reasonable explanation to the observed improvements in anaerobic power output following mouth rinsing with a carbohydrate solution. The practical application of the current findings is that short term anaerobic power output in a state of fasting and/or reduced glycogen stores can be enhanced by a carbohydrate mouth rinse. These findings are helpful for athletes who intentionally train in a reduced glycogen state to enhance their metabolic adaptations and/or to avoid gastrointestinal problems.

CONCLUSION

In conclusion, the current results demonstrate that carbohydrate mouth rinsing under a reduced glycogen state augmented the power output and that the addition of caffeine to the carbohydrate rinsing solution did not provide additional benefits.

Future studies should examine the potential effects of combining carbohydrates and caffeine in a rinsing solution using other exercise modalities with different intensities and durations.

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EFEKAT KOMBINACIJE UGLJIKOHIDRATA I KOFEINA U TEKUĆINI ZA ISPIRANJE USTA NA ANAEROBNU SNAGU U STANJU UMANJENE KOLIČINE GLIKOGENA

U ovom radu se ispituju koristi ispiranja usta ugljikohidratima, sa i bez kofeina, za anaerobni kapacitet tokom sprinta u biciklizmu u stanju umanjene količine glikogena. U uravnoteženom, dvostruko slijepom dizajnu, devet igrača futsala (dobi 21,7 ± 0,7 godina, težine 70,3 ± 10,2 kg, visine 176,3 ± 7,1 cm) je upoznato sa ispitivanjem, te su izvršili tri testa ispiranja usta: ispiranje (10 minuta) i izbacivanje bolusa od 25ml otopine ugljikohidrata (7,5% saharoze) (CHO), ili otopine ugljikohidrata i kofeina (7,5% saharoze i 1% kofeina) (C-CAF), ili placeba istog ukusa (PLA), nakon čega su 30 sekundi testirani pomoću Wingate testa (kočna težina 7,5%). Eksperimentalno ispitivanje je vršeno ujutro, nakon intenzivnog trčanja, u stanju dobrovoljne iscrpljenosti prethodne noći ili posta tokom noći. Efekat ispiranja usta na maksimalnu ($p = 0,014$) i prosječnu snagu ($p = 0,015$) ustanovljen kod PLA je značajno manji od efekta ustanovljenog kod CHO ($p < 0,05$) i C-CAF ($p < 0,05$). Minimalna snaga i indeks umora nisu bili značajno različiti između tretmana. Izlazna snaga tokom prvih 5 sekundi testiranja je bila značajno veća kod CHO u poređenju sa PLA ($p = 0,015$). Ispiranje usta ugljikohidratima poboljšava anaerobnu izvedbu u stanju umanjene količine glikogena bez korisnih efekata kada je u pitanju dodatak kofeina.

Ključne riječi: Ispiranje ugljikohidrata, ispiranje kofeina, Wingate, anaerobni kapacitet.

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SPECIFICITIES IN FINANCING SPORT AS AN ACTIVITY OF PUBLIC INTEREST

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ABSTRACT

The aim of this paper is to present a sport system financing model in Montenegro and its specificities vis-à-vis the existing international models. The attitude of public authorities in the financing system is an important determinant of the positioning of sport as a tool for the development of the broad societal needs. With this in mind, the legal regulation of sport represents a major prerequisite for setting up a financing model and the process of implementing the planned activities of public interest.

Keywords: Sport, financing, models, activity, public interest.

INTRODUCTION

Sport as a public service is vital for social and cultural development of a community, at all levels. For that reason, it is related to a wide range of policy-making and planning in the community such as health, social welfare, education, urban planning, conservation, arts and leisure.

As sports play a key role in society by contributing to the social cohesion and overcoming prejudice, its development must be supported and encouraged at all levels of society.[1]

The role of public authorities is crucial in facilitating and supporting the social function of sport for the equal benefits and access for all. Enabling both ways of cooperation with the sport movement, public authorities should promote values and a whole range of benefits from sport.[2]

The role of public authorities could be complementary to various NGOs promoting a healthy lifestyle and non-formal education in so far as its main roles include the definition and enforcement of the regulatory framework that guides the development of sports and provisions of funding for certain aspects of this development. Responsibility of the public authorities in the field of sport is not, of course, the same at the national (state), regional and loca levels.

This depends on the constitutional and legal system of each country, and in this respect in the world, there are significant differences.

INTERNATIONAL CONTEXT

In order to follow the legal constellation, understanding key actors and their responsibilities is a crucial stand point. It opens an opportunity for accessing methods of allocation or a transfer of public funds for sports development.

The draft report for the European Conference on Sport and Local Governments points out that sport is an integral part of cultural activities, as well as the vital

[1] Authors especially agreed on the economic and social segments for three reasons. First, sport is of strong cultural significance to most developed nations, which is demonstrated by the amount of media attention devoted to the national team success and the support for the construction of major stadia and other sporting infrastructure with public funds. Second, sport is considered a resource that can be used to help deliver non-sport objectives, such as demonstrating political power, combating social exclusion, reducing childhood obesity, improving economic development and facilitating urban regeneration. Third, sport is multi-dimensional in that it is not only a public service, but also an important aspect of welfare provision and a facet of economic activity. Thus, it can contribute in many ways to the achievement of government objectives outside of sport policy that is focused on instrumental aspects of sport, such as improving the performance of elite athletes and increasing participation in sport. Bergsgard, N. A., Houlihan, B., Mangset, P., N_dland, S. I., &Rommetvedt, H. (2007). Sport Policy: A comparative analysis of stability and change. Oxford: Butterworth-Heinemann.

[2] Based on Article 3, The Sport Movement from the European Sport Charter.

role of local/regional authorities in improving the living standards, economic progress and cultural development. It is urged that the representatives of local authorities proceed with the following:

- to provide adequate support and resources from public funds for the development of sport;
- to cooperate with commercial and voluntary sectors in order to promote mixed public and private assistance to sport;
- reducing financial inequality in the needs that exist between top sports and sport for all;
- promote the health and well-being of all groups and individuals who wish to engage in sports activities;
- encourage and support greater participation of older persons in appropriate sports and physical activities;
- provide opportunities for all young people to get involved in sports and emphasize the value of physical activity, and not the technical and competitive elements of sport;
- take appropriate measures to increase women's participation in sports activities;
- promote access to sports and physical activity for the least privileged groups;
- create such a climate for disabled people to get involved in sports, by recognizing their rights and improving their position in society;
- improve measures in the field of physical and health education through advertising sports and other physical activities and emphasizing their positive effect on health.

To summarize it, the recommendation emphasizes the importance of sports in policy making in the areas of education, health, social protection, urban and national planning. As a result of the conference with the aforementioned sport settings, it presupposes that local authorities provide direct public funding for sport, both through current mechanisms and capital projects.[4] Local authorities (in cooperation with the central) private and economic sectors should establish additional tools for adequate use of the available funds.

INTERNATIONAL MODELS OF SPORT FINANCING

Responsibilities and intervention of public authorities in the field of sport largely differ from state to the local level, and the system of sporting treatment depends on the normative and organizational set up. The legal framework is a prerequisite for the development of a sports system, including the implementation of a proper and specific organizational chart with principles of good governance in place. Numerous analysts define the concept of policy making as the aspiration of the ruling elite, either through an action or as an inactivity.[5] Within the wider prospective, i.e. at the Pan-EU member level, according to Andre–Noel Chaker's study "Good Governance in sport, a European survey", access to the legal regulation of sport can vary, based on the two models, in relation to three main questions: "Whether the state law regulates the terms structure and responsibilities of a significant part of the sports movement (interventionist approach) or to regulate only partially (non-interventionist approach), 2) whether state competence set is done centrally or decentralization of power, and 3) type of the sport movement; set to be on top pyramid is an organization that embraces both Olympic Committee and all national sports federations (consolidated system), and in this respect there is no difference between the Olympic Committee and other national associations, or even a general national sports federation (unconsolidated system)." [6]

The system of financing sport is based on public funds and the organization's own funds; budget financing, subsidies from the organizers of the games of chance, special tax rates, loans with lower interest rates, financing the construction, reconstruction and renovation of sports facilities, and renting facilities and sports equipment at lower prices.[7] Statistics showed that local funds (16.90%) prevail in relation to the funds from the state budget (6.95%).[8] The sport system model depends on the financing ratio, i.e., the degree of participation in sports, the level of funding per capita, the level of volunteers' involvement, as well as the contribution of households. In analysing the financing of sports, there are four models. The first model towards which the countries of Western and Northern Europe gravitate is characterized by high levels of participation in sports (over 20%) and a high GDP.

The emphasis is on the system of financing school and recreational sports. The second model, the Mediterranean model, reflects a lower GDP and more individual costs of participation in sports where the level of volunteerism is at a significantly lower level than in the first model. In the third model, which is typical of Central Europe, there is a low level of interest for recreational sports and focus on professional sports. The fourth model is a "worse" version of the previous one, where the bulk of the funds are provided from the games of chance. In addition to these, France and the United Kingdom have their "own" way of financing sports. France gravitates towards the first model with a much greater involvement of the public sector in sports in relation to the willingness of households (individuals) to contribute. In contrast, in the United Kingdom, the amount of household spending is higher than the share of the public sector. Bearing in mind the differences in development and

[4] Recommendation no. 16 (1996).
[5] For more: Heclo, H. (1972) Review article, policy analysis, British Journal of Political Svience, II, 85; Jenkins, W.I. (1978) Policy Analysis: Political and Organisational Perspectives, London: Martin Robertson; Hogwood, B. (1987) From Crisis to Complacency, Oxford: Oxford University Press.
[6] CDDS (2004) 18.
[7] The European Commission's White Paper on Sport COM (2007) 391.
[8] Eurostrategies (2011) Study on the funding of grassroots sports in the EU: Final report, Volume 1.

population, spending on sports is compared to the GDP, i.e., allocation of budget funds per capita (% amount):

Table 1: Allocation of budget funds for sport per capita expressed in percentages

	Finland	France	Germany	Sweden	Slovenia	Spain
The state budget	4.3	8.9	0.6	2.2	5.5	0.4
The local budget	24.7	29.5	26.6	20.4	20.8	5.2
Own funds	71.0	61.6	72.8	77.3	73.6	94.4
Total funds - GDP	1.13	1.1	1.28	0.8	0.6	3.47
Total public funds for sports - GDP	0.33	0.42	0.35	0.18	0.16	0.20

MONTENEGRIN SPECIFICITIES

Bearing in mind that sport plays an important role in the overall development of society and that it is therefore of public importance is often the subject of constitutional law.[9] The latter constellation in the case of Montenegro, resulted in constitutional arrangements, based on the Article 15, paragraph 1, from the Law on Procedure for the adoption and promulgation of the new Constitution of Montenegro in October 2007, the Constitution Assembly has decided on promulgation of the new Montenegrin Constitution.[10] In the Article 77 of the Montenegrin Constitution, sports and physical culture are recognized as a part of "Science, Culture and Art" section:
"Montenegro is obliged to encourage and support education, science, culture, art, sport, physical and technical culture"

The sports system is framed by the Law on Sport and a strategic document – National plan for sport (NPRS).[11] Fundamental provisions stipulated that the 'Sport is an activity of public interest', with foresees task and activities in order to achieve public interest. Further, the public interest in sport is defined as:

- promotion of sports development, in particular among children and youth;
- creation of conditions for the construction and maintenance of sports facilities;
- promotion of the MOC and national sports associations activities;
- provision of conditions for training and competitions of athletes, sports and recreational activities of children, youth and the general public, as well as other sports activities aimed at the advancement of psychophysical competencies of citizens as well as prevention of socio-pathological phenomena among children and youth;
- provision of conditions for organizing international competitions, in particular at the level of national teams;
- awarding special attention to top-level and categorized athletes;
- encouraging disabled persons to engage in sports activities;
- the creation of conditions for conducting extra-curricular sports activities for pupils and university students;
- encouraging scientific research, educational and professional work in the field of sport;
- other organized and professionally conducted sports and sporting activities.

Article 12 of the Law on Sport, foresees that the implementation of the public interest in sports shall be provided by Montenegro and the Capital City, the Old Royal Capital and the municipality. For the implementation procedure, the legislator prescribes, for both the central and local (municipal) levels, to adopt national and local plans for sport. The National Plan shall define the long-term objectives and priorities for the development of sports and determine the organizational, financial, administrative and other measures for the achievement thereof. The National Plan shall include, in particular:

- the state of affairs in the field of sport;
- the fundamental principles constituting the basis for the development of sports in Montenegro;
- short-term, mid-term and long-term objectives of sports development, as well as the stakeholders responsible for the achievement of these objectives;
- the model of financing sport;
- the content, extent and estimated value of activities required for the achievement of the planned sports development objectives;
- the obligations and tasks of the bodies and organizations involved in the achievement of the sports development objectives;
- the plan for construction of sports facilities.

In the introductory part of the NPRS, the importance of systemic financing has been recognized, bearing in mind the importance of sports for the health of the nation, social integration and other broad values of general interest. The document recognizes the "combined model" of financing sport, including public funds (state and local budgets), businesses and households. Within the state budget, 0.2% and 0.3% is dedicated to the needs of sport. At the local level, the new concept of the Law on Local Self-Government recognized a combined model of determining the local self-government affairs (the enumeration system and general clause), while determining the presumption (jurisdiction assumption),

[9] Tettinger, P. Sport alsVerfassungsthema, JuristenZeitung, br. 22/2000.
[10] http://www.skupstina.me/cms/site_data/ustav/Ustav%20Crne%20Gore.pdf (accessed on November 2017).
[11] Official Gazette no. 36/11 & 36/13.

for the benefit of the local self-government, for jobs that are not prescribed as the competence of state bodies or other public authority bodies. In the aforementioned Law on Local Self-Government, Article 32, paragraph 14, recognizes the obligations of local authorities in the field of sport: "Creates conditions for the development and improvement of sports of children, youth and citizens, as well as development of inter-municipal sports cooperation".

Bearing in mind the value and importance of sport, in particular school sports and sport for all, the same article of the Law on Local Self-Government in paragraph 16, foresees: "In accordance with the possibilities, it participates in the provision of conditions and improvement of activities: health care, education, social and child protection, employment and other areas of interest for the local population and exercises the rights and duties of the founders of institutions established in these activities, in accordance with the law ".

CONCLUDING REMARKS

The involvement of public authorities represents a major prerequisite from a regulatory point of view; providing equal opportunities for achieving the values that sport stands for. The level of involvement depends on the legal position of the sports system within the given society. International norms emphasize sport specificity, i.e. the concept of autonomy and, with this in mind, setting up an appropriate operational system and involvement of public authorities within. In the system of financing, especially in the EU countries, a high level of decentralization has been recognized (participation of local authorities in the field of financing sport in the part related to local needs). As a major form of decentralization, the principle of deconcentration is implemented in the process of transferring jurisdiction in certain funds financed from games of chances and according to the criteria financed by umbrella sports organizations.

From the provisions of the Law on Sport, the inconsistency and inadequacy of those concerning the definition of public interest and those that regulate implementation and acquisition of income in relation to the NPRS are present. The goals adopted by the NPRS, in the part of the funding system are partially implemented.

The challenge lies in the accompanying regulation, where there is no division of competencies in the field of financing. It means that, in practice, it is possible that the same sports organization (local or national character) could be financed from the central government budget (including the game of chances funds), the local self-government budget and the Montenegrin Olympic Committee budget for the same program activity. In addition to analysing this specific system of financing sport, the fact is that, in 2014, a By-law on Financing Sport Entities was introduced for the first time. In this constellation, an environment without clear control and established state priorities, for umbrella sports organizations 70% is allocated from the central government budget, and 30% for other sport entities.

Also, the lack of a strategic document in the operation and functioning of the NSFs indicates that the activities are planned ad hoc and are not necessarily following the NPRS. This year's funding represents an additional specificity, since there was no unique project form that would clearly set out the goals and methods of achieving the same and score lists for evaluating the project and methods for controlling/auditing the quality of implementation of the program. Also, although recognized by the By-law that closely regulates the co-financing of sport's needs, the direct submission of the athletes' applications was disabled. This led them to a discriminatory position in relation to other subjects (clubs/federations) in the sports system, especially in the absence of a categorization of athletes.

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SPECIFIČNOSTI U FINANCIRANJU SPORTA KAO AKTIVNOSTI JAVNOG INTERESA

Ovaj rad ima za težnju da skenira sistem finansiranja sporta u Crnoj Gori, sa osvrtom na postojeće međunarodne modele finansiranja. Odnos javnih vlasti u sistemu finansiranja, bitna je odrednica pozicioniranja sporta kao sredstva za razvoj društva. S druge strane, pravna uređenost sporta bitna je pretpostavka postavljanja sistema finansiranja sporta, sprovođenja i kontrole planiranih aktivnosti odjavnog interesa.

Ključne riječi: Sport, financiranje, modeli, aktivnost, javni interes.

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MECHANICAL AND METABOLIC EFFECT OF STANDARDIZED LOAD RESISTANCE TRAINING PROTOCOL ON UNTRAINED PARTICIPANTS

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ABSTRACT

Purpose: To determine the mechanical and metabolic responses of specifically designed standardized load resistance training protocol on untrained participants. Methodology: Fifteen untrained physically healthy males in the age of 22.5 (± 3.64) years, mass 66.6 (± 5.75) kg, height 1.69 (± 0.07) m, body mass index 23.3 (± 1.82) kg/m2) participated in this study. The participants performed an exercise protocol comprised of 5 exercises at a standardized load. Each exercise was performed with a duration of 60 seconds with an uncontrolled lifting velocity. Blood lactate accumulation at the pre and post protocol was measured for metabolic responses using a finger prick blood lactate assessment method. Vertical jump was performed on top of a force plate in the pre and post protocol for mechanical output comparison. Results: Significant differences were observed in pre and post blood lactate accumulation (p=0.001). Average blood lactate accumulation recorded pre-exercise was 2.57 (± 1.70) mmol and post-exercise was 15.7 (± 2.65) mmol. Pre-exercise maximum acceleration impulse was 2321 (±1729) N.sec with the post-exercise amounting to 2006 (±1012) N.sec. There were no significant differences between the jump pre and post maximum acceleration impulse (p=0.356). No significant differences (p=0.296) were also seen between pre (477±278 N-cm) and post (604±298 N-cm) maximum torque capabilities. Average repetitions per exercise for 60 seconds duration were 30 repetitions. Discussion and Conclusion: The prescribed protocol provides a sufficient metabolic stimulus, and seems to be metabolically challenging for untrained participants. The lack of a significant effect on mechanical performance may be due to faster recovery prior the post-test, caused by low volume load of the prescribed protocol. However, it is worthy to note that maximum torque did have a slight increase in post-exercise. This might be due to the increased movement efficiency (learning effect) of participants. Practical Application: Theprescribed protocol can be used as an introductory phase or during the early phase of strength training program for untrained population. It will also be suggested to participants who are looking for a metabolic based training and, at the same time, would like to maintain muscular power performance.

Keywords: Blood lactate, impulse, torque, endurolift.

INTRODUCTION

Blood lactate accumulation level has been widely used to measure metabolic responses towards various types of exercise and training protocol with varying intensities (Ekkekakis, Parfitt, & Petruzzello, 2011; Izquierdo et al., 2011; Yasuda et al., 2014). Basically, two types of energy systems help the body to produce energy for any activity that it performs. The first energy system utilizes the anaerobic A-lactic system, where any activity lasting less than 10-5 seconds will be supported by it(Serresse, Lortie, Bouchard, & Boulay, 1988).

The anaerobic-A-Lactic system utilizes adenosine triphosphate (ATP) stored in the muscles and the breakdown of phosphocreatine (PCr) to produce energy(Gastin, 2001). Beyond the said duration, the energy production will shift towards the second energy system, the anaerobic lactic system, which produces ATP through a systematic physiological process called glycolysis(Gastin, 2001). Approximately, for the first 10 seconds or so into the anaerobic lactic system, the ATP was produced via what can be termed as slow glycolysis. As the name implies, the second energy system through the glycolysis process produced pyruvic acid as the end product which will be cleared either by Kreb's cycle process (slow glycolysis) or converted into lactic acid (fast glycolytic)(Stainsby & Brooks, 1990). As the exercise continues, fast glycolysis will be the main energy production process, and thus, the beginning of the increase in blood lactate level accumulation in the body(Smith & Hill, 1991). If the exercise continues (beyond 2 minutes), it will slowly enter the aerobic or oxidative energy system, which through its Kreb's cycle and electron transport chain mechanism, will prevent acidification from pyruvic acid (lactate) accumulation, while continuing the ATP production process(De Feo et al., 2003).

For exercise protocols which are continuous in nature and perform beyond 2 minutes duration, the involvement of aerobic energy system as the main energy production process is well documented(De Feo et al., 2003; Duffield, Dawson, & Goodman, 2005; Gastin, 2001). However, the strength training program is normally complex in nature with involvement of both aerobic and anaerobic energy systems. Strength training protocols or regimes are typically characterized by a series of exercises performed simultaneously, with or without a short resting period in between exercises or sets within one exercise (inter-set rest period). From single exercise point of view, the suggested repetitions range as low as 3 repetitions per set up to 15 repetitions and above, with sets per exercise ranging from single set up to more than 4 sets per exercise(N I Mohamad, John B Cronin, & Ken K Nosaka, 2012). All of these are dependable on training objectives and the adaptations intended. In a combination of several exercises with several sets per training regime, cumulative exercise duration will be beyond two minutes, and with less than two minutes inter-set rest period, the stress on metabolic part will be increased. Thus, the reason why some studies have shown that physiological adaptation experienced from strength training is not just limited to anaerobic types of adaptation, but also enhances aerobic (i.e., metabolic, cardiovascular) related adaptations(Buitrago, Wirtz, Yue, Kleinoder, & Mester, 2013; Hoff, Gran, & Helgerud, 2002). Metabolic stress experienced during any exercise or physical training can be gauged via monitoring the substrates turnover and depletion, cardio-respiratory responses, hormonal perturbation and metabolites accumulation such as blood lactate(Coyle, 2000; Foulds, Bredin, Charlesworth, Ivey, & Warburton, 2014; Koundourakis et al., 2014; Schneider, 2014). Blood lactate accumulation assessed through the finger prick method has been widely used among exercise science fraternity as a simple way to gauge metabolic stress effectively (Keogh, Payne, Anderson, & Atkins, 2010; Mohamad, Cronin, &Nosaka, 2012). An increase in blood lactate accumulation of over 4 mmol/liter-1 from the onset of blood lactate accumulation, has been accepted an indicator of increased metabolic stress due to an increase in sympathetic tone normally observed in prolonged exercise duration (Karlsson, 1985). In relation to strength training, the ability to tolerate lactate accumulation which caused muscle fatigue is one of the major concerns when prescribing a strength endurance and cardio conditioning training program(Brown, Ray, Abbey, Shaw, & Shaw, 2010; Castagna et al., 2007). Strength endurance here can simply be stated as the ability to exert and maintain force without undue muscle fatigue. A study on power clean exercise has indicated that high-volume explosive training may impose greater metabolic demands than low-volume explosive training, and may improve the ability to produce power in the presence of lactate (Date, Simonson, Ransdell, & Gao, 2013).

Metabolic responses are closely related and influenced by mechanical stimulus involved during the strength training session. Mechanical responses caused by the strength training protocol can be observed from the kinetic and kinematic changes exhibited pre and post exercise (Mohamad et al., 2012; Rumpf, Cronin, Oliver, & Hughes, 2013). For the purpose of this study, impulse and torque during a vertical jump performance will be the representative of mechanical responses. Impulse is the product of force output recorded over time ($J = F \Delta t$), while torque is the moment of force or pivoting force of the body when pushing upwards (take-off phase) during the jump.

With metabolic and mechanical responses able to show the biomechanical characteristics of strength and conditioning training protocol, determining the metabolic and mechanical responses or effect of any strength training protocol will allow the end-user to properly select an exercise protocol in accordance with their training objectives. Thus, the main aim of this study is to investigate the metabolic and mechanical responses of the prescribed exercise protocol on untrained individuals.

METHODS

EXPERIMENTAL APPROACH TO THE PROBLEM

A specifically designed (customized) lifting exercise protocol was used, which consists of five exercises, each performed for one set with a standardized load for 60 seconds.

All variables of interest were assessed pre, and post exercise. Standardization of load was performed by having 20kg (Olympic bar only) load for snatch, 40kg (Olympic bar with two 10kg plates) for squat, bench press and deadlift. Dynamic plank load was based on the participant's own body weight.

Figure 1: The flow of five exercises was performed continuously from one to another, at their own velocity of movement, for the duration of 60 seconds each with standardized load.

SUBJECTS

Fifteen untrained, yet physically healthy male volunteers in the age of 22.5 (± 3.64) years, mass 66.6 (± 5.75) kg, height 1.69 (± 0.07) m, body mass index 23.3 (± 1.82) kg/m2) and currently registered as students at Faculty of Sports Science and Coaching, Sultan Idris Education University (UPSI) were recruited for the purpose of this study. All participants were recruited during the Exercise Physiology lab class on the same semester and had passed the exercise technique and blood lactate level screening. The study was approved by a university research committee and the participants signed an informed consent letter for volunteered participation.

EQUIPMENT

An Olympic bar (OB86, Body Solid Inc., Illinois, USA) and color-coded Olympic bumper plates of 10 kg (Orc series, Body Solid Inc., Illinois, USA) were used in the strength exercises. The participants' body weight was measured using a digital scale (HN-283, Omron, Kyoto, Japan). A vertical jump test was performed on top of a portable force plate (BP400600, AMTI, Massachusetts, USA) for kinetic output.

PROCEDURES

The test involved one testing occasion. Interested and volunteered participants were given a briefing related to research ethics contents, protocols involved and any associated risk factors. Short screening tests consisted of related exercise techniques assessment and pre-test blood lactate assessment was done on all volunteers' prior participation. All selected participants were those that passed both screenings. The screening aims for a selection of participants that are able to perform all exercises with appropriate techniques(Baechle & Earle, 2008) and have normal baseline blood lactate level (not performing any physically based activities that raised the blood lactate level within 48 hours prior the testing occasion). The selected participants were then measured for their standing height (cm) and body mass (kg), with a measurement of the pre-test finger prick blood lactate level (N. I. Mohamad et al., 2012). A standardized warm-up consisted of light jogging outside the laboratory until the heart rate reached 50% of the targeted heart rate for warm-up purposes, as suggested by Fox and Haskel, was performed(Fox & Haskell, 1970).

This was followed by a vertical jump test. The performed vertical jump test was a natural counter movement jump (jump as high as possible with a natural self-selected countermovement) (Jidovtseff, Quievre, Harris, & Cronin, 2014). Completing all those, the participants were given a brief 2 minutes rest from the jump before performing the exercise protocol. After the final exercise in the protocol (the dynamic plank), the participants' blood lactate level was again immediately assessed, followed with another vertical jump performance. The testing session ended with cooling down and stretching activities.

Figure 1: The five exercises involved (snatch, half-squat, bench press, deadlift and dynamic plank).

DATA ANALYSIS

Finger pricked blood lactate samples collected from readings provided by the lactate analyser were transferred into an excel sheet immediately after each analysis. Force plate vertical ground reaction force data were collected at 1000 Hz, producing impulse and torque normalised data for each of the repetition jumps performed.

STATISTICAL ANALYSIS

Means and standard deviations were used to represent centrality and spread of data for all performance measures. Paired sample T-test comparisons were used to determine whether significant differences existed between pre and post exercise data. The difference in percentages between pre and post data was calculated as %Difference = (1 – Lowest Variable/ Highest Variable)*100. An alpha level of 0.05 was set to assess statistical significance for all tests.

METHODS

Table 1 shows the mean value of the blood lactate, maximum acceleration impulse and the maximum torque during pre and post exercise protocol. Table 2 shows the mean number of repetitions completed by each participant for each involved exercise.

Table 1: Metabolic and mechanical output comparison observed pre and post exercise protocol performance.

Variables	Pre-exercise (mean ± SD)	Post-exercise (mean ± SD)	% Difference	Significance (p-value)
Blood lactate (mmol)	2.57 ±1.70	15.7 ±2.65	83.63	0.001
Maximum acceleration impulse (N.sec)	2321 ±1729	2006 ±1012	13.67	0.356
Maximum torque (N-cm)	477±278	604±298	21.03	0.296

Table 2: Number of repetitions completed by each participant for each involved exercise (mean ± SD).

No.	Exercises	Number of repetitions
1	Snatch	22.60 ±4.07
2	Squat	30.20 ±4.26
3	Bench press	23.40 ±7.74
4	Deadlift	26.27 ±5.87
5	Dynamic plank	13.00 ±3.02

DISCUSSION

The results of the study indicated a significant increase in lactate accumulation post exercise. While lactate significantly increased, the maximum acceleration impulse showed no significant changes between pre and post exercise assessment. These indicate the ability of the exercise protocol prescribed to provide significant metabolic stimulus; however, the stimulus provided was still minimal as normal recovery, within less than a minute duration after the exercise, was still able to reduce muscle fatigue significantly as indicated by no changes in mechanical capabilities on post exercise vertical jump test. Lactate accumulation over 10 mmol from performing an exercise protocol has been considered as a descriptor for a high physiological stress level (Keogh et al., 2010).

From another point of view, the number of repetitions performed indicated the near explosive or high speed muscle contraction nature of the exercise performance, as the instruction given clearly required the subject to perform as fast as possible, or explosively if possible. The result indicated that the number of repetitions performed for each exercise in average was less than 30 repetitions per participant. Considering the 60 seconds exercise duration for each exercise in the protocol, it can be calculated that the average contraction duration was around 0.5 seconds per repetition. Thus, while the lactate accumulation is high and should influence mechanical capabilities, participants seem able to maintain contraction velocity (mechanical properties) during the performance. This, against the contention that muscle fatigue was caused by lactate production, will reduce the muscle contraction ability during exercise performance. However, as a reminder, participants performed only one set per exercise, and/or one set of the protocol, which may not be sufficient to provide a sufficient mechanical stimulus. Future studies prescribing higher volume load

(i.e., an increased number of sets or load) may provide different results in terms of mechanical production capabilities.

As this study only involved untrained population, the results involving the recreationally trained and elite athletes group might differ significantly. With the load of only 40 kg, the volume load seems too low for athletic population with strength training background. A typical training program will implement at least 65% of one repetition maximum (1RM), with previous data on teenage male athletes within the same area, as this study's participants have an average 1RM of 89.76 ± 18.02 kg(Nur Ikhwan, Nicholas, Jawum, Wan, & Hamezah, 2014). Thus, the load of 40kg, as prescribed in this study, is just about 44.6% of athletic population 1RM capability. As a conclusion, the prescribed protocol provides a sufficient metabolic stimulus and seems to be metabolically challenging for untrained participants. The lack of a significant effect on mechanical performance may be due to faster recovery prior the post-test, caused by low volume load of the prescribed protocol. However, it is worthy to note that maximum torque did have a slight increase in post-exercise.

This might be due to the increased movement efficiency (learning effect) of participants.

PRACTICAL APPLICATIONS

The prescribed protocol can be used as an introductory phase or during the early phase of strength training program for untrained population. It will also be suggested to participants who are looking for a metabolic based training and, at the same time, would like to maintain muscular power performance.

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MEHANIČKI I METABOLIČKI EFEKAT STANDARDIZOVANOG TRENINGA SA OPTEREĆENJEM NA NEOBUČENE UČESNIKE

Svrha: Utvrditi mehaničke i metaboličke reakcije specifično dizajniranog, standardizovanog treninga sa opterećenjem kod neobučenih učesnika. Metodologija: Petnaest neobučenih, fizički zdravih muškaraca (dobi 22,5 (± 3,64) godine, težine 66,6 (± 5,75) kg, visine 1,69 (± 0,07) m, indeksa tjelesne mase 23,3 (± 1,82) kg/ m2) je učestvovalo u ovom istraživanju. Učesnici su bili podvrgnuti treningu koji se sastojao od 5 vježbi sa standardizovanim opterećenjem. Svaka vježba je trajala 60 sekundi uz nekontrolisanu brzinu dizanja. Akumulacija laktata u krvi prije i poslije treninga je mjerena za metaboličke reakcije koristeći metodu mjerenja količine laktata u krvi iz uzorka dobijenog ubodom prsta. Skok u vis je proveden stojeći na platformi za mjerenje sile reakcije podloge prije i poslije treninga u svrhu poređenja mehaničke izlazne snage. Rezultati: Uočene su značajne razlike u akumulaciji laktata u krvi prije i poslije treninga (p = 0,001). Prosječna akumulacija laktata u krvi izmjerena prije treninga je iznosila 2,57 (± 1,70) mmol, te 15,7 (± 2,65) mmol poslije treninga. Maksimalni impuls sile prije izvođenja vježbi je iznosio 2321 (±1729) Ns, dok je poslije izvođenja vježbi iznosio 2006 (±1012) Ns. Nisu uočene značajne razlike između maksimalnog impulsa sile prije i poslije izvođenja vježbi (p = 0,356). Također, značajne razlike nisu uočene ni između maksimalnog okretnog momenta prije (477±278 Ncm) i poslije (604±298 Ncm) izvođenja vježbi. Prosječno ponavljanje po vježbi u trajanju od 60 sekundi je iznosilo 30 ponavljanja. Diskusija i zaključak: propisani protokol pruža dovoljan metabolički poticaj, te se čini da je metabolički izazovniji za neobučene učesnike. Nedostatak značajnog efekta na mehaničku izvedbu bi se mogao pripisati bržem oporavku prije posttestiranja, što je uzrokovano niskim opterećenjem prilikom izvođenja propisanog protokola. Međutim, značajno je pomenuti povećanje maksimalnog okretnog momenta nakon izvođenja vježbi. Razlog za ovo bi moglo biti povećanje efikasnosti kretanja (efekat učenja) učesnika. Praktična primjena: propisani protokol se može koristiti kao uvodna faza ili tokom rane faze programa treninga snage za neobučenu populaciju. Također se može preporučiti učesnicima koji su zainteresovani za metabolički trening, ali bi u isto vrijeme željeli održavati mišićnu snagu.

Ključne riječi: Laktat u krvi, impuls, okretni momenat, izdržljivost prilikom opterećenja.

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DIFFERENCES OF SELF-EVALUATION ATTITUDES RELATED TO THE SCHOOLBAG BETWEEN PUPILS ATTENDING URBAN AND SUBURBAN SCHOOLS

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ABSTRACT

The main purpose of this research is to identify differences in self-evaluation attitudes related to the schoolbag between students attending urban and suburban schools. The population, from which a sample of 292 respondents was drawn out, was defined as a population of students from the 1stto the 5thgrade of urban and suburban schools in the Tuzla municipality, both sexes, aged 6 to 10 years. Two subsamples were formed from the so-defined population: subsamples of 148 pupils from urban areas and 144 from suburban areas. A survey questionnaire was used for data collection. The results obtained on the basis of testing the differences in self-assessment of the schoolbag between pupils in urban and suburban schools indicate that pupils of suburban schools have higher values of the sum of rankings when it comes to the distance between school and home, while the students of urban schools have higher values of the rankings with regard to coming to school. Protecting pupils' health is a matter of preserving not only their individual health, but also the health of society as a whole. The question of the schoolbag weight is a question that requires serious attention from the profession and competent institutions. In addition to the above-mentioned experiences of other countries, the specifics of our educational system should be consider.

Keywords: Children, Differentiation, Frequencies, Mann-Whitney U test.

INTRODUCTION

A schoolbag is a personal matter for students at the beginning of an important period of life - at school. Starting school, children will wear the schoolbags on their backs throughout the school year. Research has shown that back and shoulder pain, as well as improper posture of younger school children may be associated with over-sized schoolbags and backpacks, as well as their improper wearing habits. Many researchers in the world point to the problem of over-sized backpacks as one of the common factors responsible for the improper development of a child's posture (Hong & Cheung, 2003; Grimmer et al., 2002; Paušić, 2005). The weight of schoolbags that children carry on a daily basis, in a variety of research studies, ranges from 4.00 to 7.70 kg (Pascoe et al., 1997; Grimmer et al., 1999; Casey, 2003; Whittfield et al., 2011). Expressed in the

percentages of the children's body mass, this value ranges from 10 to 20%. Pascoe et al., (1997) conducted research in the US, where the average weight of the schoolbag was 17% of the student's total body mass. Values sometimes ranged up to 22%. Also, the research of Meckenzie et al., (2003) shows that the average relationship between the mass of the schoolbag and the mass of students ranged from 15 to 20%. The research in Croatia, for students of all grades of classroom teaching, showed that the average weight of the schoolbag ranged from 12.50% to 13.80% (compared to the pupils' mass) (Paušić&Kujundžić, 2008). Some countries respect the recommendations of the World Health Organization, legally prescribing the maximum weight that children must bear. It is believed that children should not carry more than 10% of their body mass. In 1996, the Ministry of Education in Austria decided that schoolbags should not exceed 10% of the students' body mass. In many research, different authors in the world have just mentioned the problem of over-sized school backpacks as one of the frequent factors responsible for the improper development of body posture (Hong & Cheung, 2003; Grimmer et al., 2002, Paušić, 2005). The primary purpose of this research was to determine the difference of self-evaluation attitudes related to the schoolbag between pupils of urban and suburban schools.

RESEARCH METHODOLOGY

THE SAMPLE OF RESPONDENTS

The population, from which a sample of 292 respondents was drawn out, was defined as a population of students from the 1stto the 5thgrade of urban and suburban schools in the Tuzla municipality, both sexes, 6 to 10 years old. Two subsamples were formed from the so-defined population: a subsample of 148 respondents in the urban area of Tuzla ("Tušanj", "Centar" and "Jala" Elementary Schools). a subsample of 144 respondents in the rural area of the Tuzla municipality ("Bukinje", "Gornja Tuzla" and "Simin Han" Elementary Schools).

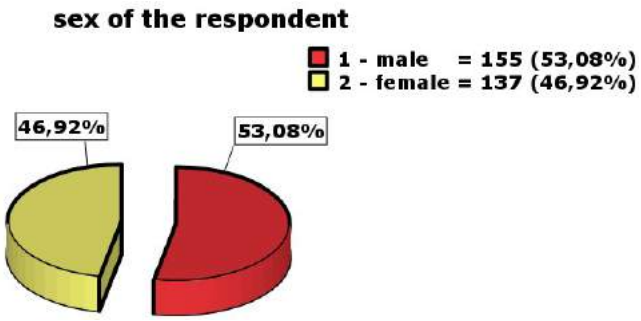
THE SAMPLE OF VARIABLES

A questionnaire with eight questions was used for data collection (Marković et al., 2015). The questionnaire was filled in during the regular classes of physical and health education with the attendance of class teachers. In the first, second and third grade, the teacher read the questions and recorded the students' answers. In the fourth and fifth grade, the questionnaire was completed by the students themselves. The questions were formulated in the following way: Gender; Class; Place of residence (URB / RUR); You come to school by (DOLSKO) (walking, car, bus, bicycle); The school is away from your home (UDASKO) (<500m, 500m - 1km, 1km - 3km, 3km - 5km); You carry the schoolbag (NOSKTO) (on one shoulder, on both shoulders); You pack the schoolbag for school (SPSKTO) (alone, with the help of the parent or elder brother / sister, the parent or brother / sister packs the bag); I consider that my schoolbag is (SMSKTO) (lightweight, normal weight, a bit heavier, too heavy).

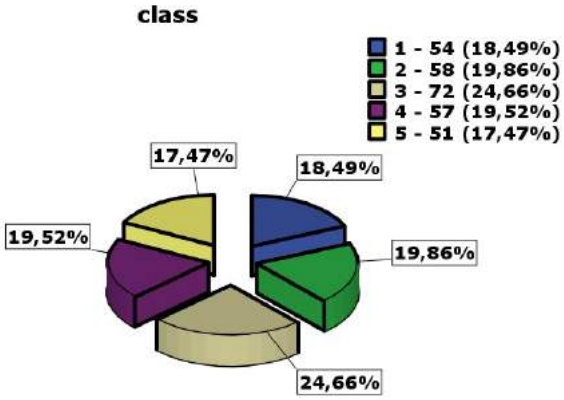
RESULTS AND DISCUSSION

by (DOLSKO) (walking, car, bus, bicycle); The school is away from your home (UDASKO) (<500m, 500m - 1km, 1km - 3km, 3km - 5km); You carry the schoolbag (NOSKTO) (on one shoulder, on both shoulders);

You pack the schoolbag for school (SPSKTO) (alone, with the help of the parent or elder brother / sister, the parent or brother / sister packs the bag); I consider that my schoolbag is (SMSKTO) (lightweight, normal weight, a bit heavier, too heavy).



Graph 1: From Graph 1., it can be seen that this survey included a total of 292 respondents. Out of these, 155 or 53.08% were male and 137 or 46.92% were female respondents.



Graph 2: There are 54 or 18.49% of the first grade students, 58 or 19.86% of the second grade students, 72 or 24.66% of the third grade students, 57 or 19.52% of the fourth grade students and 51 or 17.47% of the students attending lower grades of elementary school.

Table 1: Contains data (frequencies) of self-assessment attitudes related to the schoolbag in the examined sample.

Variable	Assertion-Attitude		Frequency (N = 292)	Percent	Valid Percent	Cumulative Percent
	1	on foot	210	71.9	71.9	71.9
	2	by car	75	25.7	25.7	97.6
DOLSKO	3	by bus	7	2.4	2.4	100
	1	> 500 m	133	45.5	45.5	45.5
	2	500 m - 1000 m	89	30.5	30.5	76
	3	1000 m - 3000 m	43	14.7	14.7	90.8
UDASKO	4	3000 m - 5000 m	27	9.2	9.2	100
	1	on one shoulder	5	1.7	1.7	1.7
NOSKTO	2	on both shoulders	287	98.3	98.3	100
	1	by themselves	241	82.5	82.5	82.5
	2	with the help of parents	43	14.7	14.7	97.3
SPSKTO	3	parent or brother / sister	8	2.7	2.7	100
	1	lightweight	13	4.5	4.5	4.5
	2	normal weight	64	21.9	21.9	26.4
	3	a bit heavier	124	42.5	42.5	68.8
SMSKTO	4	too heavy	91	31.2	31.2	100

By analysing the variable DOLSKO - coming to school it can be seen that the smallest number of children come to school by bus (7 or 2.4%), as well as walk more than three kilometres (27 or 9.2%). The most common distance is up to three kilometres. Almost all respondents carry the bag on both shoulders (287 or 98.3%). This is encouraging because it was found that carrying a schoolbag on one shoulder led to lumbar pain syndrome in children of this age (Skoffer, 2007).

241 or 82.5% of respondents pack their schoolbags themselves, suggesting that parents should pay more attention to this problem. When it comes to the weight of the schoolbag (SMSKTO), the largest number of respondents claim that the schoolbag is a bit heavier (124 or 42.5%). The obtained values are similar to those obtained in previous investigations (Casey &Dockrell, 1996; Pascoe et al., 1997; Paušić et al., 2009; Marković et al., 2013).

Table 2: Shows the differences in variables regarding the self-assessment of the schoolbag between urban and suburban students (Mann-Whitney U test), i.e. the level of significance pertaining to the differences.

Variable	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)	Mean Rank	Sum of Ranks	Group N
DOLSKO	9577.5	20017.5	-1.913	0.046*	153.79	22760.5	1 (urban) =148
					139.01	20017.5	2 (rural) = 144
UDASKO	9616	20642	-1.543	0.049*	139.47	20642	1 (urban) =148
					153.72	22136	2 (rural) = 144
NOSKTO	10578	21018	-0.481	0.638	147.03	21760	1 (urban) =148
					145.96	21018	2 (rural) = 144
SPSKTO	10559.5	21585.5	-0.203	0.839	145.85	21585.5	1 (urban) =148
					147.17	21192.5	2 (rural) = 144
SMSKTO	10142.5	21168.5	-0.758	0.449	143.03	21168.5	1 (urban) =148
					150.07	21609.5	2 (rural) = 144

The level of statistical significance is set at the conclusion level with the error (p = 0.05). The obtained results show that there are statistically significant differences in two of the five applied variables. In the first group (urban environment), respondents have higher mean values (Mean Rank, Sum of Ranks) in variables DOLSKO - school attendance, while respondents of the second group (rural environment) have higher values (Mean Rank, Sum of Ranks) in variables UDASKO - distance between school and home. This is understandable, as students in rural environments mostly come to school on foot and cross the higher distance, while students in urban areas are mostly driven by car on part of their parents.

CONCLUSION

The results obtained on the basis of testing the differences in self-assessment of the schoolbag between pupils in urban and suburban schools indicate that pupils of suburban schools have higher values of the sum of rankings when it comes to the distance between school and home, while the students of urban schools have higher values of the rankings with regard to coming to school. Recommendations for parents, teachers, the school management, school physicians and the Ministry of Education would be as follows: The contents of the schoolbags should be checked on a daily basis. Each day, parents and teachers should take a few minutes to see what the kids wear in their bags. In schools, assistants would be helped by providing lockers. Reduce the scope of the school education, which is responsible for a large number of heavy textbooks.

About 30% of the content could be ejected from the textbooks, and this does not reflect the quality of the student's knowledge. Insist on buying lightweight, anatomically shaped bags. In order to address the problem, we should not resort to measures that will result in children spending fewer and fewer time on walking to attend school (e.g.. having parents bring them to school or using other forms of transportation). Walking to school and back home (as well as cycling, etc.) is one of the measures considered to be very effective in preventing obesity during this period. It should also be noted that this does not apply to students who live too far from the school, because they need to be transported.

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RAZLIKE U STAVOVIMA SAMOPROCJENE VEZANIH ZA ŠKOLSKU TORBU IZMEĐU UČENIKA GRADSKIH I PRIGRADSKIH ŠKOLA

Osnovni cilj ovog istraživanja je da se utvrde razlike u stavovima samoprocjene vezanih za školsku torbu između učenika gradskih i prigradskih škola. Populacija iz koje je uzorak od 292 ispitanika bio izvučen, definisana je kao populacija učenika od I do V razreda urbanih i ruralnih škola sa područja općine Tuzla, oba spola, uzrasta 6 -10 godina. Iz tako definisane populacije formirala su se dva subuzorka: Subuzorak od 148 ispitanika urbanog područja i 144 ispitanika ruralnog područja. Za prikupljanje podataka primijenjen je anketni upitnik. Rezultati dobiveni na osnovu testiranja razlika u stavovima samoprocjene vezanih za školsku torbu između učenika gradskih i prigradskih škola ukazuju na to da učenici prigradskih škola imaju veće vrijednosti sume rangova kada je u pitanju udaljenost škole od kuće, dok učenici gradskih škola veće vrijednosti sume rangova imaju kada je u pitanju dolazak u školu. Zaštita zdravlja učenika pitanje je očuvanja ne samo njihovog individualnog zdravlja već i zdravlja društva u cjelini. Pitanje težine školskih torbi pitanje je koje zahtijeva ozbiljnu pažnju struke i nadležnih institucija. Uz navedena iskustva drugih zemalja treba uzeti u obzir i specifičnosti našeg obrazovnog sistema.

Ključne riječi: Djeca, diferencijacija, frekvencije, Mann-Whitney U test.

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MOTIVE PREPAREDNESS OF SCHOOL-AGE CHILDREN UNDER THE INFLUENCE OF SPECIAL EXERCISES AFFECTING THE STATE OF THE ACOUSTIC ANALYSER

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ABSTRACT

Purpose: to define the extent of influence of specially directed exercises on the functional state of the acoustic analyser and the level of physical fitness in pupils aged 7-15 years. Material: Research were conducted on the basis of general education institutions of Kharkov. More than 800 pupils, of whom experimental and control groups were made, took part in the research: the I age group – 7-year-old pupils, the II age group – 8-year-old pupils, III age group – 9-year-old pupils (pupils of elementary school), IV age group– 10-11-year-old pupils, V age group – 12-13-year-old pupils, VI age group – 14-15-year-old pupils (pupils of middle school). Results: the functional state of the auditory sensory system and motive preparedness of pupils aged 7-15 years is investigated; differences of the studied indicators in age and sexual aspects are considered; a positive influence of specially directed exercises on the functional state of auditory sensory system is revealed. Conclusions: 1. As a result of the initial research, an insufficient level of functioning of the pupils' acoustic analyser is established. 2. The correlation analysis showed a possibility of interference of the acoustic analyser parameters and a manifestation of motive qualities. 3. The application of specially selected exercises positively influenced the functioning of the acoustic analyser and, indirectly, affected the examinees' motive preparedness.

Keywords: : Physical education, school-age children, sensory systems, motive qualities.

INTRODUCTION

The tendency for an aggravation of school-age children's health symptoms is observed at the present stage of the development of society in the majority of countries throughout the world (Haskell, Lee, Pate, et al., 2007; Bala, 2012; Mameshina, 2016); therefore, the problem of searching the most effective ways for improving the impact on pupils gains increasing relevance. Motor activity is an important component of forming, preserving and strengthening health and development of an individual, especially during childhood. However, experts note its decrease when it comes to school-age children (Sallis, Prochaska & Taylor, 2000; Penedo & Dahn, 2005). The deficiency of motor activity can be compensated by an increase in the pupils' interest in classes and physical exercises, which is possible to reach due to an introduction of innovative approaches in the process of physical education. At school, many experts dealt with issues of improving the process of physical education (Maslyak, Mameshina & Zhuk, 2014; Bala, 2015; Legrain, Gillet, Gernigon, & Lafreniere, 2015; Aghyppo, Tkachov & Orlenko, 2016). Authors such as Geppert, Coleman, Mailloux & Smith-Roley, 2004; Aghyppo & Kuzmenko, 2015; Parham & Mailloux, 2010; Maslyak, Shesterova, Kuzmenko

et al., 2016; Podrigalo, Iermakov, Potop et al., 2017, note the important role of sensory systems (visual, auditory, vestibular, tactile) in physical education and sports, without normal functioning of which the correct performance of movements is impossible.
The acoustic analyser is the second most important analyser, promoting human perception of the environment. The ear reacts to mechanical influences, connected with periodic changes of atmospheric pressure in the corresponding range. The air fluctuations, operating with certain frequency, are characterized by periodic manifestations of areas of high and low pressure, perceived by the person as sounds. The value of hearing in human life, as one of the main channels for obtaining information on the world around them, is high. Hearing, expanding the information field considerably facilitates socialization, allows the person to be guided freely in space and to perceive the movements of their own body (Blamey, Sarant, Paatsch et al., 2001; Coch, Sanders & Neville, 2005; Litovsky, 2011).

The acoustic analyser, in physical culture and sports, is of great importance because it takes part in the perception of the teacher's or coach's verbal remarks, promotes faster formation and implementation of movements and the development of physical qualities. In the course of physical education, exercises are often performed to the sound of music or rhythm which set the sound signals (Lyubomirskiy, 1974; Maslyak, 2008; Kuzmenko, 2011).

According to Ermolaev, 1985, the final morphofunctional formation of hearing organs in children comes to its end before the child is 12 years old. Therefore, school age is optimum for the improvement of the auditory sensory system functions.

Training with the inclusion of special exercises has considerable influence on the increase in the functional state of the acoustic analyser and, indirectly, on the level of physical fitness at various contingents of pupils (Shesterova, 1998, 2003; Maslyak, 2006, 2015; Kuzmenko, 2014). However, despite the existence of separate publications in this speciality, the question of influence pertaining to the functional state of the auditory sensory system on the level of motive preparedness of school-age children is insufficiently studied.
The purpose of the research - to define the extent of influence of specially directed exercises on the functional state of the acoustic analyser and the level of physical fitness in pupils aged 7-15 years.

MATERIALS AND METHODS

The research were conducted on the basis of general education institutions of Kharkov. More than 800 pupils, of whom experimental and control groups were made, took part in the research: the I age group – 7-year-old pupils, the II age group – 8-year-old pupils, III age group – 9-year-old pupils (pupils of elementary school), IV age group– 10-11-year-old pupils, V age group – 12-13-year-old pupils, VI age group – 14-15-year-old pupils (pupils of middle school). All children, who participated in the research, belonged to the main and preparatory medical groups.
During the academic year, the content of physical education classes for pupils placed in experimental groups was complemented with specially selected physical exercises and outdoor games, which are directed towards the activation of the acoustic analyser such as: giving orders with a change of timbre and loudness; music with a change in speed and rhythm; attention exercises with the use of sound irritants and hindrances; performance of exercises with a restriction of the acoustic analyser opportunities.

Special exercises were included in the preparatory, main and final parts of lessons; sports minutes were practiced during lessons of general education subjects, and, in the system of organized changes, exercises were also given in the form of homework. Besides, the main and final parts of lessons were complemented with the modified outdoor games, and their content joined the above listed exercises.
Research methods: analysis of scientific and methodical literature, pedagogical testing, methods of defining indicators for separate functions of the auditory sensory system, pedagogical experiments, methods of mathematical statistics.

Pedagogical testing assumed the use of motive tests for determining the level of development of the main physical qualities. So, the level of speed development was determined by the results of a 30 m (s) run for 7-9-year-old pupils and 60 m (s) for 10-15-year-old pupils; the coordination of movement (dexterity) was determined by the results of a 4x9 m (s) shuttle run; flexibility was determined with the trunk bending forward from a sitting position (cm); the force by a bending extension of hands in a lying position (number of times) and torso lifting in a set from a back-lying position (number of times); the endurance by a 500 m (min., s) run for 7-9 year-old pupils and 1000 m (min., s) for 10-15-year-old pupils.

The research of separate functions related to the auditory sensory system was conducted by the method of acoumetry, allowing the defining bone and airing conductivity of sound waves with the use of a tuning fork of 140 Hertz for examinees of the I - III groups and 440 Hertz for pupils of the IV-VI groups.

Statistical analysis: research materials were processed with the use of the Excel program. We calculated: the arithmetic average ( ) – for the characteristics of the set in separate parameters; standard error of the average (m) – for the definition

of the deviation for average population, arithmetic from the corresponding parameters; reliability of distinctions (p) – calculated with the purpose to establish the extent of changes in average sizes of the studied signs after the experiment conducted by means of the parametrical criterion of the student (t) at the significance level not lower than 0.05.

RESEARCH RESULTS

Data from the initial research on separate parameters of the functional state of the auditory sensory system allowed to establish the lack of reliable differences in indicators of experimental and control groups' pupils (p>0.05).

The analysis of initial results, reflecting the functional state of the pupils' acoustic analyser for the I-III groups, showed their improvement with age, according to air and bone conductivity. Indicators of girls belonging to the II age group, whose separate results were slightly better than the results obtained for other pupils of elementary school, are an exception. The tendency of an increase in sound audibility indicators at air and bone conductivity is also observed in pupils of the IV-VI age groups.
When studying indicators depending on gender, it was revealed that the boys' results surpass those obtained for girls. Data on air conductivity of the examinees belonging the IV group and bone conductivity for pupils of the II and IV groups, where the girls' results are higher, are the exception. It should be noted that these differences in the pupils' air conductivity indicators for the I, IV, V and VI age groups have no reliable character (p>0.05), and the results obtained by studying the II and III groups are reliable (p<0.05-<0.001). Data on bone conductivity have no reliable distinctions (p>0.05), except for indicators related to pupils of the IV age group, where the results have a reliable character (p<0.05).

As a result of the analysis, various sound audibility duration is found in the right and left ears. So, sound transmission parameters for the left ear at pupils of all age groups are slightly better than those for the right one.

Considering the results, which were received after carrying out the experiment, the reliable improvement of the sound audibility duration in pupils belonging to the experimental groups of all age is revealed (p<0.05-<0.001) (Fig. 1-3).

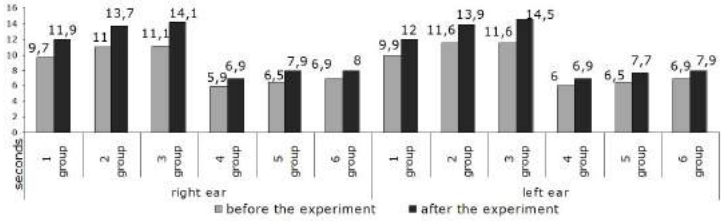

Figure 1: Air conductivity indicators for boys belonging to the experimental groups before and after the experiment

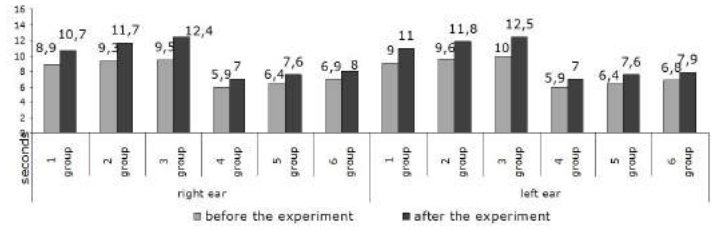

Figure 2: Air conductivity indicators for girls belonging to the experimental groups before and after the experiment

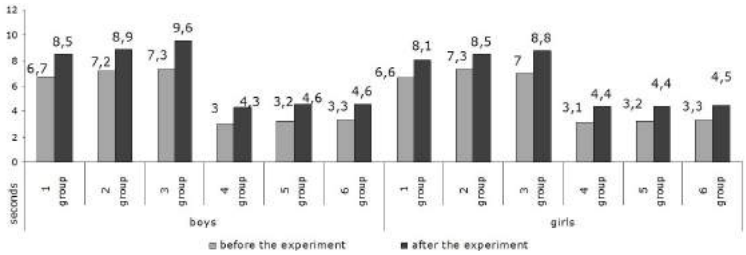

Figure 3: Bone conductivity indicators for pupils belonging to the experimental groups before and after the experiment

So, the obtained indicators of bone conductivity were 27.5%, air conductivity for the right ear – 22%, for the left ear – 21.3% in boys of the I age group; the II age group – 23.9%, 23.8% and 20.2%, respectively; the III age group – 31.7%, 26.8% and 24.6%, respectively; the IV age group – 41%, 17.3%, 16.4% respectively; the V age group – 42.7%, 21.8%, 19.1% respectively; the VI age group –37.8%, 15.9%, 13.8% respectively.

For girls of the I age group, sound audibility duration on indicators of bone conductivity improved for 21.5%, air conductivity for the right ear improved for 19.9% and for the left ear, it improved for 22.8%; the II age group – for 16.5%, 25.6% and 23.1%, respectively; the III age group – for 26.3%, 30.5% and 25%, respectively; the IV age group – 40.9%, 26.9%, 19% respectively; the V age group – 37.2%, 18.8%, 18.4% respectively; the VI age group – 36.8%, 16.6%, 15.5% respectively.

Thus, the most significant gain of the sound audibility duration is noted in pupils aged 9-11 years. It should be noted that, generally, a more essential increase in air conductivity indicators is observed in girls of all age groups in comparison with boys. The results of air conductivity for the pupils' right ear in the I group, and the pupils' right and left ears in the V group are an exception, with an increase in indicators prevailing for boys. The opposite tendency is observed for bone conductivity indicators: more essential gain of results is noted in boys than in girls.

Upon the termination of the experiment, indicators of pupils from the control groups are also a little improved; however, these changes are neither considerable nor reliable ($p>0.05$)

The analysis of the results in age and sexual aspects didn't reveal essential changes of rather basic data. Thus, the special exercises we used positively affected the functional state of the acoustic analyser – sound audibility duration increased significantly, both for bone, and air conductivity in pupils of all age groups. At the same time, the greatest gain of results for air conductivity is observed in girls, and bone conductivity in boys. It is revealed that the acoustic analyser of 9-11-year-old pupils is most susceptible to training. The exercises we offered positively affected not only the functional state of sensory systems, but also motive preparedness of the examinees. So, the indicators of speed manifestation and high-speed and power qualities improved for pupils participating in the experiment, in 97% of cases; in 93% of cases, there were manifestations of dexterity and in 95% of cases manifestations of flexibility were present. The smallest gain was observed in the results reflecting the level of development for the muscular strength of hands and prelum abdominale – 79% and 87% respectively. It is necessary to focus our attention on various changes in indicators of the level of endurance development in elementary and middle school pupils. So, the indicators improved in 95% of cases at examinees of middle school age, and the results of endurance manifestation did not practically change for younger pupils.

Changes in indicators of the level of motive preparedness were observed in 45-50% of cases for pupils belonging to the control groups, which is connected, in our opinion, with age features of their development.

By analysing the improvement of indicators in the age aspect, it is established that the most essential changes are recorded in speed indicators for 7-year-old boys, and in prelum abdominale muscular strength indicators for girls of similar age. At the age of 8 years, the most considerable changes happened in the boys' flexibility indicators and in the results of speed manifestations and prelum abdominale muscular strength for girls. At the age of 9 years, the most essential changes are recorded in indicators of speed, dexterity, muscular strength of hands and prelum abdominale for boys and in flexibility indicators for girls. For 11-year-old boys, the most significant changes in indicators of high-speed abilities, endurance, dexterity and muscular strength of hands were recorded. For girls of this age, the indicators of endurance, dexterity, flexibility, muscular strength of hands and prelum abdominale improved most significantly. At the age of 12-13 years, a substantial increase in indicators of prelum abdominale muscular strength and flexibility for boys, and high-speed abilities for girls was observed. Less significant rates of gain in indicators of motive readiness were noted at the age of 14-15 years, both for boys, and girls. The comparison of results between boys and girls allows for saying that the girls are more susceptible to impact of specially directed exercises in all age groups at higher absolute measures of motor abilities development than boys.

The correlation analysis was carried out for the purpose of defining the extent of influence of separate parameters for the auditory sensory system on the level of 7-15-year-old pupils' motive preparedness. The obtained data confirm the existence of interrelation degree, "average" in size, between the studied parameters (the coefficient of correlation varied ranging from 0.21 to 0.65 at $p<0.05$-0.01). So, the correlation coefficient varied, ranging from 0.33 to 0.65 at $p<0.05$-0.01 between indicators of the acoustic analyser and the level of speed development; for dexterity, it varied from 0.33 to 0.57 at $p<0.01$; for forces, it varied from 0.20 to 0.64 at $p<0.05$; for flexibility, it varied from 0.20 to 0.46 at $p<0.05$-0.01; for endurance, it varied from 0.21 to 0.41 at $p<0.05$. The tendency of interrelation remained at the repeated research. It was revealed that interference of the studied parameters depends on age, and in some cases on gender.

DISCUSSION

According to experts in the field of physiology, physical education and sport (Riemann & Lephart, 2002; Geppert, Coleman, Mailloux & Smith-Roley, 2004; Heekeren, Marrett, Bandettini & Ungerleider, 2004; Maslyak & Terenteva, 2007; Gold & Shadlen, 2007; Pomeshchikova, 2010), sensory systems play an important role in the course of the pupils' physical education.

Numerous works are devoted to studying the influence of special exercises on the function of separate sensory systems (Pomeshchikova, Ermakov et al., 2016; Podrigalo, Ermakov, Rovnaya et al., 2016; Maslyak, Shesterova, Kuzmenko et al., 2016). At the same time, authors note that purposeful influence of physical exercises on sensory systems leads to the improvement of motor skills and an increase in the level of physical fitness. As Coch, Sanders & Neville, 2005; Solodkov & Sologub, 2005; Litovsky, 2011, note, the acoustic analyser plays an important role in movement performance. An opportunity to regulate movement speed on distance and analyse separate elements of movements (frequency, duration of phases), etc. (Pain & Hibbs, 2007) is connected with the function of the acoustic analyser (Shelton & Kumar, 2010). By analysing the results of the conducted research, it should be noted that, after the exercises, directed to increase the functional state of the acoustic analyser, were applied during physical education classes, the reliable improvement in air and bone conductivity indicators occurred in pupils of all experimental groups ($p<0.001$). During regular physical exercises, the cerebral cortex, owing to the plasticity of its activity, influences functional changes, directing the reaction of systems and coordinating their activity: commands are perceived by the acoustic analyser and this irritation passes to motor neurons which causes the necessary movement (Solodkov & Sologub, 2005; Litovsky, 2011).

For the improvement of the acoustic analyser functions, according to Lyubomirskiy, 1974, various sound irritants have great value. Special attention paid in the process of training is present due to the sound signals (music, verbal synchronization of actions, sound irritants, etc.) during the performance of physical exercises by children, owing to their broad perception and the speed of forming the conditioned-reflex communications. We experimentally confirmed the efficiency of similar methodical receptions.

In the course of the conducted research, the most significant improvement of results for air and bone conductivity happened in the case of 9-11-year-old pupils, which could be explained by the morphofunctional formation of hearing organs in children, which, according to Ermolaev, 1985, finally comes to its end before the child is 12 years old.

Indicators of pupils belonging to the control groups also improved a little during the experiment, but these changes are insignificant and doubtful ($p>0.05$).
The works of Penedo & Dahn, 2005; Pomeschikova, 2010; Bala, 2015, etc. are devoted to studying the physical fitness of pupils. Authors offer various means for its increase. We investigated the influence of special exercises on indicators of separate functions of the auditory sensory system and, as a result, on the change in the level of the pupils' physical fitness.

Indicators of high-speed abilities in all age groups, both for boys and girls, authentically improved ($p<0.001$). The most significant increase in the results was observed in 9-13-year-old pupils. The obtained data confirm the research of Lyubomirskiy, 1974, who specified that the sensitive period of speed development is the age of 9-14 years. In our opinion, the gain in high-speed abilities of the studied experimental groups was promoted by a rather close interrelation between them and the studied sensory system indicators (Gold & Shadlen, 2007; Pain & Hibbs, 2007; Shelton & Kumar 2010).

After the application of specially directed exercises, which positively affected the acoustic analyser indicators, the results in the level of force development for the studied experimental groups authentically improved ($p<0.01–0.001$). The data on pupils belonging to the I - III groups make an exception because the changes have a reliable character only at the age of 8-9 years ($p<0.05$; 0.01). The most significant increase in the results was noted for 11-13-year-old pupils. The obtained data confirm the opinion of authors that force indicators improve with age (Lyubomirskiy, 1974; Shesterova, 1998; Maslyak, 2008).

The repeated analysis of indicators of the coordination abilities' level of development revealed a reliable improvement of results in pupils belonging to the experimental groups ($p<0.001$). The most considerable changes happened in examinees at the age of 8-11 years. In our opinion, the gain in indicators of the coordination abilities' level of development is explained by a rather high degree of their dependence on the studied sensory system functionality (Riemann, Bryan, Lephart & Scott 2002; Parham & Mailloux, 2010; Kuzmenko, 2011).

Owing to the experiment, flexibility indicators for pupils belonging to the experimental groups authentically improved ($p<0.05–0.001$). The greatest gain in results was observed for 9-11-year-old pupils. It was established that the results of the flexibility level of development have less significant interrelation with indicators of the studied sensory system functions, in comparison with other physical qualities. The essential gain of results in exercises on flexibility is, in our opinion, also connected with the change in the level of development of other

physical qualities. As a result of applying specially directed exercises, endurance indicators of the studied experimental groups improved. It should be noted that the distinction has a reliable character in pupils of the IV-VI groups ($p<0.001$), and, in pupils of the I - III the group, the reliability of distinctions is not marked out ($p>0.05$). The most essential gain of indicators is recorded in 11-year-old pupils, which is, in our opinion, connected with the improvement of the children's cardiovascular and respiratory systems function (Solodkov & Sologub, 2005). Indicators of the level of physical fitness for pupils belonging to the control groups also underwent changes; however, they are less essential and are not reliable ($p>0.05$).

The results, which were obtained in the repeated research, allowed us to establish a positive influence of specially directed exercises on the auditory sensory system indicators and, as a result, on the level of the pupils' motive preparedness. We determined the terms for the optimal application of exercises for the purpose of the impact on the motive qualities' level of development to be 9 years of age for the junior group of examinees and 11-13 years of age for examinees belonging to the group of secondary school students.

Therefore, the conducted research confirms and supplements the results of research conducted by certain authors (Solodkov & Sologub, 2005; Shelton & Kumar, 2010; Litovsky, 2011) on the efficiency of its application in the educational process of the exercises, which are directed towards an increase in the functional state of the acoustic analyser.

CONCLUSIONS

1. Data obtained in the initial research on separate parameters of the functional state of the auditory sensory system allowed for establishing the insufficient level of development of the acoustic analyser in 7-15-year-old pupils.
2. The application of specially directed exercises in the course of physical education positively affected the functional state of the studied sensory system of pupils belonging to the experimental groups ($p<0.05–0.001$). The most susceptible period for training the acoustical sensory system is the age of 9-11 years.
3. The research on the level of physical fitness after using the system of specially directed exercises demonstrate a reliable improvement in the level of development of all main physical qualities ($p<0.05-0.01$) in pupils belonging to the experimental groups. 7-9 year-old pupils' endurance indicators, which practically did not change, are an exception. The most essential gain of results is mainly noted at the age of 9 years (in the junior group of examinees) and at the age of 11-13 years (in the group of secondary school examinees). Data on pupils belonging to the control groups did not significantly change.
4. The correlation analysis of the acoustic analyser functional state indicators and the level of motive qualities' development confirms the existence of average interrelation between them, which assumes the possibility of interference of these parameters.
5. The conducted research demonstrate the positive interfaced influence of the offered complexes of specially directed exercises on the functional state of the auditory sensory system and the level of pupils' physical fitness that allows us to recommend teachers of physical culture, elementary school teachers, sports coaches and parents to supplement the content of the physical education process, sports trainings and pupils' independent motor activity with the system of specially directed exercises we developed.

Further research in this direction can be conducted through a definition of the extent of influence the acoustical sensory functions level of activity has on motive preparedness of high school pupils.

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CONFLICT OF INTEREST

The authors note that there is no conflict of interest which can be perceived as such that it can do harm to the impartiality of the article.

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MOTORIČKA SPREMNOST DJECE ŠKOLSKOG UZRASTA POD UTICAJEM POSEBNIH VJEŽBI KOJE UTIČU NA STANJE AUDITIVNOG ANALIZATORA

Svrha: definisati opseg uticaja posebno usmjerenih vježbi na funkcionalno stanje auditivnog analizatora i nivo fizičke spremnosti učenika u dobi od 7 do 15 godina. Materijal: Istraživanja su provedena na osnovu institucija općeg obrazovanja u Harkovu. Više od 800 učenika, koji su činili eksperimentalnu i kontrolnu grupu, je učestvovalo u istraživanjima: I dobna grupa - učenici u dobi od 7 godina, II dobna grupa - učenici u dobi od 8 godina, III dobna grupa - učenici u dobi od 9 godina (učenici osnovne škole), IV dobna grupa - učenici u dobi od 10 do 11 godina, V dobna grupa - učenici u dobi od 12 do 13 godina, VI dobna grupa - učenici u dobi od 14 do 15 godina (učenici srednje škole). Rezultati: istraženo je funkcionalno stanje auditivnog senzornog sistema i motorička spremnost učenika u dobi od 7 do 15 godina; razlike proučavanih indikatora po pitanju dobi i pola su uzete u obzir; otkriven je pozitivan uticaj posebno usmjerenih vježbi na funkcionalno stanje auditivnog senzornog sistema. Zaključci: 1. Nedovoljan nivo funkcionisanja auditivnog analizatora učenika je utvrđen kao rezultat početnog istraživanja, 2. Korelacijska analiza je pokazala mogućnost uticaja parametara auditivnog analizatora i pojavu motoričkih osobina. 3. Primjena posebno odabranih vježbi je pozitivno uticala na funkcionisanje auditivnog analizatora i, indirektno, na motoričku spremnost ispitanika.

Ključne riječi: Fizičko obrazovanje, djeca školskog uzrasta, senzorni sistemi, motoričke osobine.

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BASIC AND SPECIFIC MOTOR SKILLS OF FEMALE HANDBALL PLAYERS

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ABSTRACT

Task performance in handball matches depends upon the motor skills of female players. In this paper, 10 tests were applied on a sample of 45 female handball players to evaluate their basic motor skills, and 5 tests to evaluate their specific motor skills. Contributions of certain motor variables in explaining female handball players' basic and specific motor skills were also determined.

Keywords: Basic motor skills, specific motor skills, female handball players.

During a match, all the activities that female handball players perform consist of diverse movements and motions carried out in non-standard conditions, and manifested on the basis of their motor skills.

Motor skills of male and female handball players have been topics of research conducted by authors like: Gabrijelić (1977), Kovač, J. (1977, 1988, 1989), Pavli, Šimenci Delija (1982), Miler (1982), Kovač, M. (1986 and 1992) iĐukićiKovač J. (1990). In the beginning, research related to motor skills have been conducted in a manifest area with the goal of assessing certain motor skills of the respondents. Later on, research started to deal with latent dimensions of motor skills using a phenomenological or a functional approach.

The research goal was to determine either the dimensions pertaining to parts of the motor skills area or the dimensions of the area as a whole, as well as the relations between certain groups of the motor skills dimensions or its relation with other anthropological (morphological, cognitive, conative, sociological, functional) dimensions.

In this paper, the authors have reduced the system of variables used for assessing basic and specific motor skills of female handball players to one dimension per each and examined the contribution certain variables provide in their explanation.

MATERIAL AND METHODS

THE SAMPLE OF RESPONDENTS

The sample consisted of 45 female cadet handball players, 14-16 years old, who have been training handball on a regular basis for at least two years.

TEST SAMPLE

Tests for assessing basic motor skills
In order to assess basic motor skills, one test was applied for each dimension. The most important dimensions of basic motor skills, as well as the most adequate tests for their assessment have been determined based upon research conducted by numerous authors.

1. Foot tapping (TAPNOG) - for assessing the speed of movement frequency in lower extremities
2. Hand tapping (TAPRUK) - for assessing the speed of movement frequency in upper extremities
3. Turning the stick over one's head (ISKPAL) - for assessing the shoulder girdle flexibility
4. Hand and foot drumming (BURUNO) - for assessing

coordination
5. Side steps (KORSTR) - for assessing agility
6. Standing high jump (SARDŽE) - for assessing the explosive strength of lower extremities
7. Medicine ball throw from the laying position (BAMELE) - for assessing the explosive strength of upper extremities
8. Torso lift in 60 sec. (PODTRV) - for assessing repetitive strength
9. Shooting a horizontal target (GAHOCI) - for assessing accuracy
10. PWC170 (PWC170) – for assessing the cardiac functional efficiency.

1. Tests for assessing specific motor skills
2. Shooting accuracy (PREPOG) - for assessing situation accuracy
3. Throwing a ball against the wall alternating between the stronger and weaker hands and catching the rebound ball (BAHVAL) - for assessing the skill of ball handling
4. Dribbling in a square (BRVOQ) - for assessing the speed of movement with the ball
5. Slalom run (BRKRET) - for assessing the speed of movement without the ball
6. Far jump shot (BACLOP) - for assessing the strength of a ball throw.

DATA ANALYSIS

After calculating the basic descriptive statistical parameters, the contribution of certain variables in explaining the basic and specific motor skills was determined by using a principal component analysis.

RESULTS

The basic descriptive statistical parameters of the female handball players' basic and specific motor skills are shown in Table 1 and Table 2. The data represents an average in the female cadet handball players' skills and can only serve as an orientation value, because the average results come from female handball players who are 14-16 years old (the span of three calendar years). The contribution given by the applied system of variables in explaining basic motor skills was explained on the basis of the system reduction to one dimension that carries the largest amount of information extractable from the stated system of manifest variables. It is shown in Table 1. The total contribution of the first principal component in explaining basic motor skills is 24.4% (Table 1, Lambda = 2.44%, %=24.4). The highest correlation (N, Table 1) with the general subject of measurement (basic motor skills) was shown in variables for assessing: agility (KORSTR = -.73*), the speed of hand movement frequency (TAPRUK = .66), the explosive strength of lower extremities (SARDŽE = .62), coordination (BURUNO = .58), repetitive strength (PODTRU = .58) and accuracy (GAHOCI = .48).
The contribution of the specific motor variables system as a whole in explaining the female handball players' specific motor skills was 35.4% (Table 2, Lambda =1.92; % =38.4). The correlations of variables (N, Table 2) with the common specific motor skills of female players were: the strength of a ball throw (BACLOP = .83), ball handling (BAHVAL = .78), the speed of movement with the ball (BRVOĐ = .68), situation accuracy (PREPOG = .35) and the speed of movement without the ball (BRKRET = .21).

DISCUSSION

The qualitative values of the female handball players' basic and specific motor skills (Table 1 and Table 2) show that the whole system of variables contributes to explaining their basic motor skills with a 24.4 percent, and specific motor skills with a 38.4 percent.

According to this, it seems that, in this case, even though it has a smaller amount of tests, the system of specific motor tests explains the general subject of measurement better than the system of basic motor tests. On the one hand, the cause of this is probably a more adequate choice of specific motor tests, and on the other hand, it is possible, in the words of M. Gajić (1985), that, due to training, the basic skills were modified according to the specificity of the sport, i.e. handball.

In relation to the participation extent of certain variables in explaining the female players' basic motor skills (Table 1A), the sequence is: agility, the speed of hand movement frequency, the explosive strength of lower extremities, coordination, repetitive strength and accuracy.

All the stated basic motor skills are, apart from repetitive strength, important for a quality male or female handball player, which is confirmed in the research conducted by Kuleš and Šimenac(1983), Pačić (1973), Ćukić (1990), Kovač and Đukić (1991).

A relatively small contribution of the PWC170 test in explaining basic motor skills is understandable because the test is primarily used for assessing cardiac efficiency, which is not stable at that age.

On the other hand, endurance as a basic motor skill is not only dependent upon a good function of the cardiovascular system, but also upon a series of other factors (substance exchange, the condition of the nervous system, coordination of all the functions, motivation, morphology, movement technique and the like), and the question of testing endurance as a motor skill has not yet been clarified (M. Gajić 1985).

The participation extent of certain variables in explaining the female handball players' specific

motor skills (Table 2) is in line with the hypothetical model of a successful handball player. Particularly, in relation to qualitative indicators of specific motor skills, the model emphasises strength and accuracy of the throws, the skill of ball handling and the speed of movement with and without the ball as the most important ones.

CONCLUSIONS

10 tests were applied on a sample of 45 female handball players to evaluate their basic motor skills, and 5 tests to evaluate their specific motor skills.

The principal component analysis method determined the contributions of certain variables in explaining the female handball players' basic and specific motor skills in the sense that:

The common basic motor skill of female handball players was best explained by agility, the speed of hand movement frequency, the explosive strength of lower extremities, coordination, repetitive strength and accuracy;

The sequence according to the participation extent of specific motor variables in explaining the specific motor skills is the strength of a ball throw, the skill of ball handling, the speed of movement with the ball, shooting accuracy and the speed or movement without the ball.

Table 1: The first principal component of the variable intercorrelation matrix for assessing the female handball players' basic motor skills - Lambda = 2.44%=24.4

Variables	h	SD	H
1. TAPNOG (freq.)	36.7	4.5	.28
2. TAPRUK (freq.)	29.7	4.7	.66
3. ISKPAL (em)	67.9	15.8	-.08
4. BURUNO (freq.)	7.8	3.0	.58
5. KORSTR (0.1 sec.)	134.2	10.9	-.73
6. SARDŽE (cm)	32.0	5.5	.62
7. BAMELE (cm)	627.9	169.8	.28
8. PODTRU (freq.)	34.4	4.6	.58
9. GAHOCI (point)	13.8	5.4	.48
10. PWC170 (formula)	930.6	230.7	.09

Table 2: The first principal component of the variable intercorrelation matrix for assessing the female handball players' specific motor skills - Lambda = 1.92%=38.4

Variables	h	SD	H
1. PREPOG (point)	23.0	8.8	.35
2. BAHVAL (freq.)	16.6	2.7	.78
3. BRVOĐ (0.1 sec.)	118.6	12.6	.68
4. BRKRET (0.1 sec.)	160.7	12.5	-.21
5. BACLOP (cm)	1857.1	450.5	.83

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BAZIČNE I SPECIFIČNE MOTORIČKE SPOSOBNOSTI RUKOMETAŠICA

Realizacija zadataka u rukometnoj igri zavisi od motoričkih sposobnosti igračica. U ovom radu, na uzorku od 45 rukometašica, su primenom deset testova procenjenenjih ove bazične motoričke sposobnosti, a primenom pet testova njihove specifične motoričke sposobnosti. Utvrđeni su takođe doprinosi pojedinih motoričkih varijabli u objašnjenju bazične i specifične motorike rukometašica.

Ključne riječi: Bazične motoričke sposobnosti, specifične motoričke sposobnosti, rukometašice.

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PHYSICAL EFFORT AND SPORT EXPERTISE CAN MODULATE FACIAL FATIGUE PROCESSING

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ABSTRACT

This study focuses on the effect of sport expertise and the intensity of effort on the opponent facial fatigue recognition between karate players (KD) and soccer players (SC). We hypothesize that long practice of combat sport can positively affect the ability of the opponent facial expressions processing. Nineteen karatekas and 17 soccer players participated in this study. The participants performed a facial recognition task while running on a treadmill in 5-different conditions (i.e., rest, 60%, 80%, 100% and 120% of maximal aerobic speed, MAS). The results revealed that motor resonance increased with the increase in the intensity of the effort. It was also revealed that KD were faster and more precise in recognizing facial expressions than SC. The advantage of KD over SC in facial expressions processing was principally present in the maximum intensity of effort conditions. In conclusion, our study showed that long-term practice of karate ensures the development of the ability of the opponent facial expressions processing.

Keywords: Facial recognition, soccer, karate, motor resonance, physical effort.

INTRODUCTION

The Mirror Neurons System (MNS) is a cortical action perception coupling system that helps us to embody not only other individual's intentions, but also their state of mind, which can allow subsequent interactions with the observed agent [1, 2]. Furthermore, it has been shown that MNS is directly linked to the development of social cognition [3, 4]. This social cognition is directly affected by the capacity of human face recognition. During facial expression recognition, mirror neurons fire and provide an internal simulation of the observed motor comportment that induces a similar emotion in the observer's mind; this phenomenon is known as motor resonance [5, 6]. This motor resonance enables the identification of the perceived emotion, feeling [7], state [8] or action [9]. This fact is very interesting, but it is insufficiently explored in sports where athletes engage all their physicals and mental abilities to achieve a better performance. Moreover, in the cited studies, motor resonance is examined without involving any physical effort. In modern sports, it is essential to present the athletes with an exhaustive preparation in order to improve all their physical, technical and mental skills. One of these mental skills is the recognition of the opponent's facial expressions. In spite of the high importance attributed to the facial expressions recognition during the effort, few studies have focused on this subject. The opponent facial expressions can inform us about his fatigue state which can represent valuable information to control the effort during the competition. Furthermore, an expert in a contact sport should know if the opponent would try to dissimilate his fatigue. This ability of facial expressions recognition was never studied under different levels of physical effort. In this study, we compared the capacity of fatigue face expression recognition within and between karateka and soccer players. We hypothesize that the expertise in activities soliciting emotional state recognition capabilities such as combat sports would result in more effective processing of this type of information. Moreover, in collective sports (i.e., soccer), and fighting sports (i.e., karate), high demand on visual allocation of

attention and information processing (related to the ball position, the opponent, and the teammate) are treated under temporal pressure and coupled with high physical effort that is maintained throughout the duration of the competition [10, 11]. Consequently, the aim of this study is to determine the effects of physical effort (short time effect) and expertise (long time effect) in soccer (SC) and ka-rate (KD) on the recognition of the opponent's fatigue condition.

METHODS

PARTICIPANTS

Thirty-six volunteer high level athletes participated in this study. The group consists of 19 karateka (age 21.7±1.30 years; height 1.75±0.03 m; mass 69.62±7.50 kg) and 17 soccer players (age 23.2±1.2 years; height 1.77±0.08 m; mass 72.99±3.76 kg). All were volunteers and had at least 10 years of sport practice. They are active and regularly participated in the national championships of the two cited disciplines. They are right-handed and have physical and visual ability as testified by medical certificates.

After being informed, in advance, about the procedures, methods, benefits and possible risks involved in the study, a written consent was obtained from participants. The experimental protocol was performed in accordance with the Declaration of Helsinki for human experimentation and was approved by the Ethical Committee of the laboratory. The experimental protocol was explained to the subjects without presenting the aims of the study in order not to bias the results. The experiments were conducted in the middle of the sports season, four to five months after the start of the competitive period. Participants were asked to maintain their fitness level throughout the experimental period.

EXPERIMENTAL DESIGN

This experiment included two parts. The first part was devoted to the determination of the maximum maximal aerobic speed (MAS) of each participant. The second covered the effect of physical effort and sport expertise on the face recognition ability. The experiment lasted three weeks; in which the participant visited the laboratory four successive times to undertake the treadmill assessment protocol at rest, 60%, 80%, 100% and 120% of his MAS. These assessment sessions were counterbalanced Latin square and spaced by a 72 hours recovery period each.

EVALUATION OF THE MAXIMAL OXYGEN CONSUMPTION AND MAS DETERMINATION

Participants completed seven assessment sessions. In the first one, participants received complete information about the experiment and gave their consent to take part in this study. In the second session, participants were required to perform a VO2max Test following the protocol described by Harling et al. [12] in order to determine the maximal aerobic speed (MAS). In this study, MAS is the final speed achieved and maintained for 1 min during the VO2max test.2.4.

Cognitive Study - In session, 3 to 7 participants performed the facial recognition information processing speed (IPS) task while running on a treadmill. The task was performed in 5 different effort levels (E); rest (participants don't walk), E60 (60% of MAS), E80 (80% of MAS), E80 (100% of MAS), and E120 (120% of MAS); in each level, MAS was controlled by the speed and the heart rate, and the order of the five conditions was counterbalanced (Latin square).

The choice of these levels of effort was founded on the specificity of the karate competition; this sport is based on a very high intensity duration of attack separated by periods of assault preparation whose intensity were sub maximum [19, 20]. Each physical exercise intensity condition lasted 2 minutes. This duration was chosen due to two reasons; the first one was linked to the rules of karate competition. The second reason was related to the specificity of the efforts. It is extremely difficult for the participants to maintain a maximum (E100) or a supramaximal (E120) intensity of the MAS for more than 2 minutes.

The task involved 40 trials. The participant had one minute to attain the target speed and then the task started automatically and lasted 2 minutes for each effort level of MAS. The participant's task was to indicate whether the images of faces displayed on the screen express moderate or intensive physical effort. The succession of stimuli was pseudo random. The directive given to KD and SOC emphasized both speed and accuracy. The participants did not receive any feedback about the accuracy or the IPS of their response. Each trial of the facial effort recognition task took 3 seconds (figure 1). It began with a fixation cross (+) displayed in the centre of the screen (750 to 1000ms), directly followed by a facial image stimulus. The image remained observable until the response execution or if the response time exceeded 1000ms. The response that surpassed 1000ms was considered as omission. The trial ended with a white screen as an intertrial interval (1000 to 1250ms).

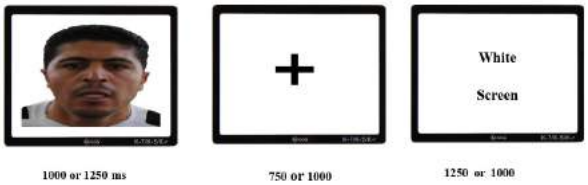

Figure 1: Protocol design

STATISTICAL ANALYSIS

Data are reported as means ± standard deviations (SD) and confidence intervals at the 95% level (95% CI). All variables were tested for normality by the Shapiro-Wilk test and results showed that the data were normally distributed. Therefore, the ANOVA for repeated measures were applied to compare percentages of effort and face recognition. The sphericity was assessed by the Mauchly test. When the assumption of sphericity was not met, the significance of F-ratios was adjusted according to the Greenhouse-Geisser test. The Bonferroni post-hoc test for paired comparison, was used to determine the significant differences. The magnitude of these differences was controlled according to Cohen's effect sizes (n2). The following scale was used to interpret the n2: around 0.1 is described as "low", 0.25 as "medium" and 0.4 as "strong". The significance level was set at 0.05% (p≤.05). The statistical analyses were carried out by the Statistical Package for the Social Sciences version 20.0 (SPSS® Inc., Chicago, IL, USA).

RESULTS

The results of this study (table 1) showed that there was no significant difference between the KD and the SC group at rest and at 60% of the MAS. This was observed both in the percentage of responses and in the level of IPS. However, at 80% of MAS, the KD group recognized the facial expression of fatigue with a better accuracy than the SC group; this difference was significant at p<0.5 (fig. 2). Moreover, the results between the two groups showed a significant difference at p<.001 on the IPS in the sense that the KD group respond more rapidly than the SC group to the images expressing 120% MAS effort level (fig. 3). It is clear that the difference between the two groups starts at the 80% MAS effort level (E80% MAS) and above; this deference was observable for image expressing high effort level (i100% and i120%) but not for a low effort level (rest image and i60%). For more details see table 2 and figure (3, 4, 5 and 6).

Table 1: ANOVA repeated measure for image recognition at different levels of MAS

Variables	MD	SD	Sig.
E80%PRRi120	11.558	4.368	0.011*
E80%TRRi120	-84.350	21.988	0.000**
E100%PRRi100	25.361	5.262	0.00*
E100%PRRi120	19.435	4.345	0.000**
E120%PRRi80	25.283	6.031	0.000**
E120%PRRi100	14.585	5.838	0.016*
E120%PRRi120	9.425	3.111	0.004**
E120%TRRi120	-102.604	27.363	0.000**

Abbreviations: E80%, E100%, E120%: level of effort at 80%, 100% and 120% of maximum aerobic speed (MAS). PRRi120: percentage of recognised responses image 120% MAS level, TRRi120: time of recognised responses image 120% MAS level, PRRi100: percentage of recognised responses image 100% MAS level, PRRi80: percentage of recognised responses image 80% MAS level.

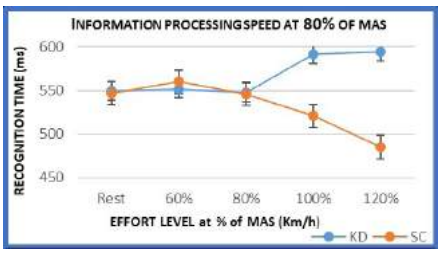

Figure 2: Information processing speed at 80% of MAS

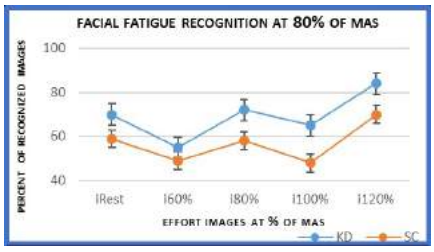

Figure 3: Percentages of recognized responses at 80% of MAS

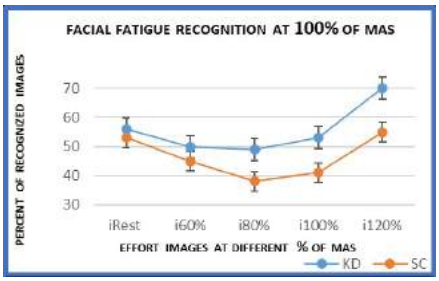

Figure 4: Percentages of recognized responses at 100% of MAS

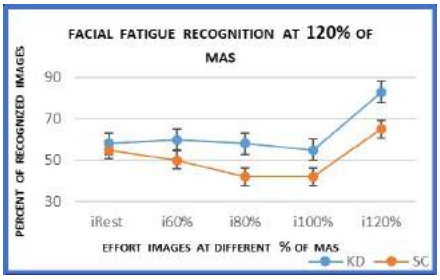

Figure 5: Percentages of recognized responses at 120% MAS

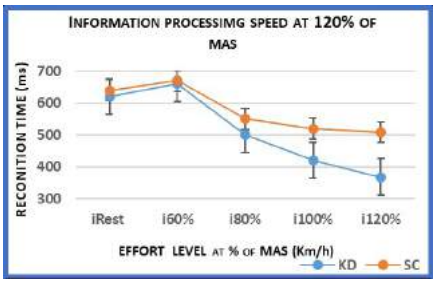

Figure 6: Information processing speed at 120% of MAS

DISCUSSION

In this study, we compared the capacity of fatigue face expression recognition within and between karateka and soccer players in five levels of MAS (rest, 60%, 80%, 100%, and 120%). We hypothesize that the expertise in an activity soliciting emotional state recognition capabilities such as combat sports would result in more effective processing of this type of information. The results of the study clearly show that the capacity of fatigue states recognition in other players is better in KD compared to SC. The difference in information processing speed (IPS) between the two groups dramatically increased at a high intensity of effort E120% (369.714±55.802; 509.429±35.270, respectively). The results for IPS can be explained by Davey's (1973) [14] exercise arousal cognition interaction theory. Davey perceived low intensity exercise as being equal to low arousal, moderate intensity corresponding to moderate arousal and high intensity exercise as inducing high levels of arousal. Moreover, in their study, Urrutia et al, 2012, [15] used fMRI to examine brain responses to counterfactual statements considering actions of high and low physical effort. The results revealed that the inferior parietal lobule, recognized to support the planning of object directed actions, was stimulated more strongly to high effort than to low effort statements. Further, counterfactual statements, compared to factual ones, engaged a distinctive neural network partially overlapping with action execution networks. This statement supported the idea that the effects of acute physical exercise on cognitive performances depend on physical exercise characteristics (i.e., type intensity and/or duration), as well as on cognitive task requirements [16, 17, 18]. Submaximal physical exercise appears to exert a facilitating effect on cognitive performances on a large range of tasks.

At rest, the subject has low ability to discriminate between the rest image and the 80% and 100% MAS IMG in the sense that he recognizes an image at rest much better than one at effort. This is also the case when comparing 60% MAS IMG against 80% and 100%. This can be explained by the fact that 60% MAS IMG is seen as the rest state (more details will be given below); moreover, it can be explicated by the absence of the effect of physical effort that can enhance the arousal linked to better information processing [19]. While at rest, the subject can easily distinguish between rest and 120% MAS IMG; this facial expression of high intensity efforts was easily observable to the participants than any other effort image.

Within groups, when the subject undertakes the experiment under the E80% effort level, he can sensibly discriminate between the rest state images, 120% effort images and his actual condition (E80).

When investigating the 100% effort level, the within group analysis demonstrates some ability to identify the 100% level as well as the dissimilarity between the 100% state and the rest state. On the other hand, the 120% level is again more obviously readable when compared to the 100% MAS level. At 120% MAS level, KD can clearly distinguish the supramaximal effort from any other effort level. Actually, all the recognition frequencies lie above 72%. It seems that E120% is the most recognised effort for both KD and SC; however, there is a significant difference between KD and SC at $p<0.001$; KD recognised this effort much better than SC.

Let us consider now the 60% of MAS discussion. The first observation related to the between group performance mainly indicates one difference consisting of the recognized response percentage at 120% MAS IMG. The result reveals that the KD is in a much better position than SC to recognize that the supra maximal IMG is different from the 60% MAS IMG. Otherwise, both athletes show total uncer-tainty in responding at 80% and 100% MAS IMG. Worse, both KD and SC perceive the rest IMG as 60% MAS IMG and viceversa. This says that the 60% effort level constitutes a unique state, far different from the other MAS levels, suggesting further future studies to better apprehend its specificities. Perhaps, our first conjecture is that the motor resonance [3, 5, 6; 20] starts after the 60% of MAS effort. However, much more needs to be investigated.

The information processing speed (IPS) witnesses some interesting behaviour when comparing KD with SC. Actually, at rest, both types of athletes possess practically the same response time. At 100% level of effort, the difference becomes significant in favour of KD who proved the ability for much faster response. The tendency of decrease in IPS continues for KD to reach an overall improvement of about 30% compared to the rest state. In contrast, the IPS for SC goes even worse at 120% than at rest. This says that, while no clear pattern may explain the relationship between the

levels of effort and the IPS for SC, there is some considerable improvement in processing time for KD as the level of effort increases. This can be consistent with Davey's (1973) exercise arousal cognition interaction theory for karateka. Davey perceived a direct matching between the effort intensity and the arousal level, so that the higher the intensity, the higher the arousal level. It is well known that the IPS decreases with the increase of the arousal level. In a similar context, some studies [21, 22] reported the importance of dopamine in the improvement of IPS. However, this is not applicable for SC. This can be explained by the fact that, during the game, soccer players exclusively focus on the lower part (hip, knee, and ankle) of the opponent's body, as well as on the ball position [23]. Hence, there is no learning curve for SC with respect to facial expressions of the opponent. On the other side, during the game or the training sessions, KDs focus on the opponent's upper body, including his face, [24] to predict the opponent's next move. A recent study supposed that structural adaptations are sport specific and are established in cerebral areas linked to the neuronal treatment of sport specific skills, which means that long term KD practice can modify cerebral plasticity to fit the specificities of this fighting sport [25].

CONCLUSION

The long-term practice of combat sport improves the capacity of karateka to recognize facial fatigue expressions of their opponents. This capacity is more improved in high intensity effort then in low effort intensity. But this capacity seems to be less improved by the long-term practice of soccer. This mean that sport specificity can affect the motor resonance capacity and mental ability of athletes depending on the practiced sport. Future neuropsychological studies involving functional imagery techniques may be able to accurately distinguish the cerebral structures implicated in such cerebral plastic modification.

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FIZIČKI NAPOR I STRUČNOST U SPORTU MOGU UTICATI NA PREPOZNAVANJE UMORA NA LICU

Ovo istraživanje se fokusira na efekat stručnosti u sportu, te intenzitet napora prilikom prepoznavanja umora na licu protivnika kod karatista (KD) i fudbalera (SC). Pretpostavljamo da dugoročna praksa u bori-lačkim sportovima može pozitivno uticati na sposobnost prepoznavanja izraza lica protivnika. 19 karatista i 17 fudbalera je učestvovalo u ovom istraživanju. Učesnici su izvršavali zadatak prepoznavanja izraza lica za vri-jeme trčanja na pokretnoj traci u 5 različitih uslova (tj. odmor, 60%, 80%, 100% i 120% maksimalne aerobne brzine, MAS) Rezultati su otkrili da se motorička rezonanca povećala sa povećanjem intenziteta napora. Također su otkrili da su KD bili brži i precizniji pri prepoznavanju izraza lica od SC. Prednost koju su KD imali nad SC prilikom prepoznavanja izraza lica je prije svega izražena u maksimalnom intenzitetu u uslovima na-pora. Zaključno, naše istraživanje je pokazalo da dugotrajna praksa karatea osigurava razvoj sposobnosti prepoznavanja izraza lica protivnika.

Ključne riječi: Prepoznavanje izraza lica, fudbal, karate, motorička rezonanca, fizički napor.

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AN ENTREPRENEUR AS A LEADER IN SPORTS

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ABSTRACT

Every entrepreneurial venture begins with a personal initiative, which is the yield of healthy ambitions, a desire to achieve something new. Entrepreneurial courage and willingness to take risks are necessary in order to achieve personal initiative. Qualified knowledge, the ability of a good prognosis, and monitoring trends in a particular social branch are necessary to carry out ideas. If an appropriate business plan asserts the appropriateness and justification of the idea, the entrepreneur begins with the realization or launch of a business. To make business grow and develop, it is necessary to possess a willingness for constant training and orientation towards innovation. Entrepreneurial processes include: initiative, entrepreneurial courage, idea, business plan, business start-up and training. An entrepreneur is an innovator and does not necessarily have to create something new to be an entrepreneur. It is enough if he or she can recognize and see a new chance and a new way of performance in the market. Entrepreneurship as a business activity is very important for all areas of social life, as well as for sports.

Keywords: Entrepreneur, processes, management, innovativeness.

INTRODUCTION

The best and true examples of entrepreneurship in our environment are the success of Serbian tennis players on the world stage, with great financial support from family, both in the training process and in the inexhaustible investment of capital. When it comes to competing sports, there are numerous sports halls, bowling alleys, balloons for five-a-side football and other gym sports. Traineeships and recreational sports are tailored to the needs of a modern man, seeking for a healthy way of life and a new lifestyle, and the best example of this are many fitness centres, gymnasiums, spa centres and other recreational and sports facilities. Entrepreneurs are the ones who are the first to understand the possibility of profiling new offers in the services sector of the sport and the wishes of our users in a rational way. Practice has shown that a large number of entrepreneurial ventures in the sports industry have found their market value. This strengthens competition, raises quality, and reduces the cost of services. Management is a continuous process of solving problems faced by an enterprise in carrying out its business activities. In other words, it is of notable significance because the total result includes a series of activities and actions that are performed together in a continuous manner. It is also the process of unifying and directing the individual resources necessary to carry out business activities. Necessary but unrelated resources are integrated into the overall business system to achieve the goals of business, in our case goals of sport.

CHARACTERISTICS OF A SUCCESSFUL ENTREPRENEUR IN SPORTS

A successful entrepreneur in sports is a person who recognizes an opportunity; that possesses knowledge, experience and skills in creating effective organizations through which to materialize their ideas. An entrepreneur is brave, determined, willing to take the risk and face the time challenges. He is an innovator, leader, manager who has a proactive attitude towards future events, and a strong desire for great achievements and the ability to compete with rivals. An entrepreneur in sports is a motivator, coordinator,

organizer. He wants changes, responds to them and uses them as an opportunity.

An entrepreneur in sports promptly and efficiently responds to changes, and also creates them. Whether it is an entrepreneur-business owner or entrepreneurs who realize their ideas within large business systems, a successful entrepreneur is definitely a person possessing the ability to find new business opportunities. A successful entrepreneur in sports possesses:

- Ability to recognize an opportunity
- Confidence in his own ideas, his knowledge and abilities
- Willingness to face all risks and challenges
- A proactive attitude
- Organizational skills
- Leadership skills
- Ability to establish good communication
- Flexibility, creativity, persistence and determination
- The desire to compete and win
- Complete dedication to work
- A passion for affirming his own business
- Passion for finding new chances and opportunities
- A tendency toward improvement.

Entrepreneurship in sports is a very expansive area all over the world. Sport is today the largest growing economic sector in the world that brings steady income and continuously brings new customers and creates new markets.

Sport, as a business, is a new industry with unimaginable potential, as it is an inexhaustible source of new business opportunities. Therefore, the entrepreneur in sports is the one who sees and recognizes these opportunities and uses them in the same way.

The development and internationalization of professional sports, as well as the presence of a large number of institutional and individual investors, who want to invest capital in professional sports, have demanded the necessity of having a superior professional sports management.

Sport management by content, activity, method and technology does not differ much from the management of other business sectors in the same way that management in a professional sports club is no different from a management in any other company.

Access to professional management is a basic prerequisite for improving sports and business activities of a club, optimal functioning of a club, as well as ongoing rationalization of the work process and achievement of positive business results. Professional sports management aims to highlight managerial activity and managerial responsibility of people involved in the realization of the main sports and business functions in the club: basic sports activities, finance, marketing, organization and development, logistical activities etc.

EXPERIENCE OF A SUCCESSFUL ENTREPRENEUR IN SPORTS

In order to be a successful entrepreneur in sports, a very important role for success, besides personal characteristics, is experience. The previous managerial experience of entrepreneurs, as well as the experience of other businesses, can be of great benefit for the successful start of a new business. (Nadoveza, 2011)

It is common in both foreign and domestic business practice that people who have had important managerial positions in their companies or clubs for years have, thanks to their knowledge, expertise, market knowledge, high quality contacts, at a moment when they see a new business opportunity, decided to start their own business in the same economic sector. (Radosavljević 2008)

The most powerful resources and the driving force of such an entrepreneurial endeavour is the experience gained through well-known areas. In such situations, risk, as an important factor that influences the success of a future business, is controlled and reduced to the smallest possible extent.

An entrepreneur who is starting his own business, based on experience from the same branch of industry or the same social field, has a great chance of gaining competitive advantage in the market.

Therefore, it is no accident that people in sports, as a rule, former athletes, in most cases, start entrepreneurial businesses in the sports industry.

Owners of newly-built sports facilities, balloons, halls, spa and recreational centres, gymnasiums, sports schools and special sports programs are mostly former sportsmen, coaches or sports workers.

Each of these entrepreneurial endeavours is based on an authentic sports experience.
Experience as a characteristic of a successful entrepreneur in sports is seen in several forms:

- Previous managerial experience in any social or economic sphere
- Previous experience in starting a business of any kind
- Previous management experience in the field of sport
- Authentic sports experience of actors (former athletes, trainers, sports workers ...).

SKILLS OF ENTREPRENEURS IN SPORTS

In addition to personal characteristics and experiences, entrepreneurial skills are of great importance. They can be classified as:

- Innate skills
- Professional skills
- Practical skills.

Every successful entrepreneur in sport must possess a smaller or greater amount of innate skills (genetic potential, man born to be an entrepreneur, a man with an initiative), as well as skills acquired through a system of general education and vocational training (schools, vocational training, faculties, specializations) and skills gained through practice.

Just like every athlete should have an innate talent as a necessary condition for every sports achievement, which over time improves with training, in order for the athletes, after several years of hard work and effort, to have good sports results, every entrepreneur in sports must have this same set of skills to be successful in his business.

A COMPARISON OF INCOME STRUCTURE OF PROFESSIONAL FOOTBALL CLUBS IN SERBIA AND EUROPE

Table 1: Presentation of the European Football Club's revenue structure for the season 2011/12, (in millions of euros), Deloitte Football Money League, 2013

CLUB	Total income (millions)	Ticket sales		TV rights		Commercial rights	
		€	%	€	%	€	%
Real Madrid	516.6	123.6	25	199.2	39	187.2	36
Barcelona	483.0	116.3	24	179.8	37	186.9	39
Manchester United	395.9	122.0	31	128.5	32	145.4	37
Bayern München	368.4	85.4	23	81.4	22	201.6	55
Chelsea	322.6	96.1	30	139.4	43	87.1	27
Arsenal	290.3	117.7	41	107.7	37	64.9	22
Manchester City	285.6	38.1	13	109.0	38	138.5	49
Milan	256.9	33.8	13	126.3	49	96.8	38
Liverpool	233.2	55.9	24	78.2	34	99.1	42
Juventus	195.4	31.8	16	90.6	47	73.0	37
Borussia Dortmund	189.1	31.4	17	60.4	32	97.3	51
Inter	185.9	23.2	13	112.4	60	50.3	27
Tottenham	178.2	50.8	28	76.1	43	51.3	29
Schalke 04	174.5	43.1	25	38.0	22	93.4	53
Napoli	148.4	24.6	16	85.8	58	38.0	26
Olympique de Marseille	135.7	18.1	13	70.6	52	47.0	35
Olympique Lyonnais	131.9	17.7	14	71.6	54	42.6	32
Hamburger SV	121.1	40.0	33	23.0	19	58.1	48
Roma	115.9	14.7	13	64.4	55	36.8	32
Newcastle	115.3	29.5	26	68.7	59	17.1	15

Table 2: Review of the audit company BDO - revision of football clubs for 2013

Club	Organization status	Business through another legal entity	Budget (seasonal costs) EUR million	Participation of transfers in funding sources (%)	City's share of funding sources (%)
OFK Beograd	Association of Citizens	No	1.6	90%	0%
Sloboda Užice	Association of Citizens	No	0.8	50%	40%
Spartak Subotica	Association of Citizens	No	1	74%	0%
Mladost Lučani	Association of Citizens	Yes	n/a	n/a	n/a
Radnički 1923 Kragujevac	Association of Citizens	No	1	48%	40%
Vojvodina	Association of Citizens	No	2.9	71%	0.4%
Napredak	Association of Citizens	Yes	1.6	9%	0%
Donji Srem	Association of Citizens	No	0.3	19%	27%
Metalac	Association of Citizens	No	0.4	0%	0%
Jagodina	Association of Citizens	No	1.7	44%	32%
Radnički Niš	Association of Citizens	No	1.1	0%	38%
Borac Čačak	Association of Citizens	No	0.8	83%	8%
Sloga Kraljevo	Association of Citizens	No	0.1	0%	89%
Novi Pazar	Association of Citizens	Yes	n/a	n/a	5.4%
Rad Beograd	Social enterprise	No	n/a	90%	0%
Crvena Zvezda	Association of Citizens	Partially	15	36%	0%

Table 3: Review of the audit company BDO - revision of football clubs for 2013

Club	Liabilities (EUR million)			Net asset value (equity) EUR million	Situation with the stadium	Payments of earnings under Article 84a
	Transfers	Employees	Taxes and endowment			
OFK Beograd	0.062	n/a	n/a	-0.120	without permission to use	yes
Sloboda Užice	-	n/a	n/a	-0.367	with permission to use	yes
Spartak Subotica	-	0.014	0.007	0.233	with permission to use	no
Mladost Lučani	-	-	-	n/a	with permission to use	no
Radnički 1923 Kragujevac	-	-	-	-0.455	with permission to use	yes
Vojvodina	0.538	0.844	0.504	-2.565	with permission to use	yes
Napredak	-	0.155	0.080	-1.122	with permission to use	yes
Donji Srem	-	0.010	0.023	-0.165	with permission to use	no
Metalac	-	0.004	0.002	-0.016	unclear	yes
Jagodina	-	0.118	0.067	0.026	with permission to use	yes
Radnički Niš	-	0.079	0.128	-0.600	with permission to use	yes
Borac Čačak	0.023	0.008	0.005	-0.204	without permission to use	yes
Sloga Kraljevo	-	-	-	-0.216	without permission to use	yes
Novi Pazar	n/a	0.057	0.034	n/a	with permission to use	no
Rad Beograd	0.025	0.27	0.98	-1.500	without permission to use	yes
Crvena Zvezda	2.9	4.784	3.596	-14.500	ownership	yes

AN ENTREPRENEUR IN SPORTS AS A LEADER

Leadership and possession of leadership skills are one of the key features of a successful entrepreneur. Leadership is the process of influencing people to voluntarily and enthusiastically achieve common goals. To be a successful entrepreneur in the sport, it is necessary to be well managed. This means that he has to possess abilities and knowledge greater than others and to gain domination in every respect. Leadership is the most complex management function. A sports enthusiast must possess the skill of targeting and organizing people to achieve their common goals and their mission (Drejker, 1991). The key to success is to clearly define duty and have authority.

A sports enthusiast must have a certain authority over his employees, meaning that they must see in him a man who will satisfy their own personal interests and needs. They need to be motivated to accurately estimate their motives and wishes in order to be able to maximize their potential. The modern leader must know how to read between the lines to see what you see, to hear what cannot be heard and must listen in order to be heard (Životić, 2007). A successful leader must have an idea.

The best and most successful athletes of today are undisputed leaders in their teams They possess very pronounced leadership skills, which enables them to be successful leaders. In the entrepreneurial business, in the field of sports industry, leadership skills are also of undeniable significance. This does not mean that the one who was the undisputed leader in the sports field, would be the same in business, but it is quite clear that anyone who does not have leadership skills in business can hardly count on success. A successful leader who leads his group of people has to know that planning (setting courses of action), organizing (making structures) and monitoring (ensuring results) are crucial in business.

A charismatic leader is a master in the process of inspiring others to work hard in order to perform important tasks. Such a leader can only achieve this with great enthusiasm that relies on the talents and the ability of employees to achieve the goals and implement plans. The definition of leadership can be determined by the following key elements (Northaus, 2008):

- Leadership is a process,
- Leadership has an impact,
- Leadership occurs in the context of a group and
- Leadership should lead towards the achievement of goals.

Based on these statements, we can say that leadership is a process in which an individual has an influence on the followers to achieve organizational goals through change.

Successful planning of a sports organization requires that all aspects of its action be connected and represented in a unique business plan (Veselinović, 2012). Increasing the chances of business success requires that, before the start of the establishment or the new planning cycle, research and evaluation of the activity in which the business will take place, as well as the goals are done. Based on the use of the obtained information, a comprehensive and well-planned business plan is being developed, which should help achieve the set goals. (Tomić, 2006).

Management is a continuous process of solving problems faced by an enterprise in carrying out its business activities, that is, it is of particular importance because the overall result includes a series of activities and actions that are carried out together in a continuous manner. It is also the process of unifying and directing the individual resources necessary to carry out business activities. Necessary but unrelated sources are integrated into the overall business system to achieve business goals.

The management's role is to integrate, coordinate and address subsystem activities and put them in a rational relationship with the environment in which the company carries out its business activity. The company seeks to minimize the negative and optimize the positive performance of the individual factors that adapt and affect it. The management process must be tailored to provide the enterprise with survival, stability and growth. Management is a way to establish an appropriate balance between the growing needs of the economy and society and the ability of the company to efficiently and effectively address these needs.

CONCLUSION

The entrepreneur needs to have enough knowledge to determine the clear purpose of his business, to develop a strategy that is consistent with the set goals and to ensure a successful implementation of that strategy. In doing so, the choice and implementation of the strategy should be seen as a dynamic process where the strategy needs to be improved, customised, supplemented and adjusted to meet the needs of the market. Only under these conditions an entrepreneur has a chance to survive on the market. Every entrepreneur should have a good vision in order to inspire the entire staff.
In the last twenty years, sport has come to the stage in which it has become one of the three most profitable industries in the world, and this requires an entrepreneurial approach to management, thinking as a leader and acting as one. Entrepreneurship in sport

by its essence, scope, structure and mode of realization is not different from the entrepreneurship of any other economic activity, precisely because a large number of entrepreneurial programs present in professional clubs are implemented through joint ventures in different sports branches and through the connection of sports with other complementary activities. The best example for these are the major sports equipment manufacturers who develop special programs of business cooperation with professional clubs that combine the quality of equipment manufacturer brand and the professional club, its market strength, i.e. rating. Sports and professional clubs offer great opportunities for entrepreneurs to develop new business ventures and opportunities to earn revenue and profit. A successful entrepreneur in sports is a person who recognizes a chance, and has the knowledge, experience and skills to create efficient organizations through which to implement and materialize their ideas.

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PREDUZETNIK U SPORTU KAO LIDER

Svaki preduzetnički poduhvat započinje ličnom inicijativom, koja je plod zdravih ambicija, težnje za ostvarenjem nečeg novog. Za ostvarenje lične inicijative neophoda je preduzetnička hrabrost i spremnost na rizik. Da bi došlo do realizacije ideje, potrebna su kvalifikovana znanja, sposobnost dobrog predviđanja, kao i praćenje trendova u određenoj društvenoj grani. Ako odgovarajući biznis plan da potvrdu svrsishodnosti i opravdanosti ideje, preduzetnik pristupa realizaciji, odnosno pokretanju biznisa. Da bi biznis zaživeo i razvijao se, potrebno je posedovati spremnost za stalna usavršavanja i usmerenost ka inovativnosti. U preduzetničke procese spadaju: inicijativa, preduzetnička hrabrost, ideja, biznis plan, pokretanje biznisa i usavršavanje. Preduzetnik je inovator i ne mora neminovno da stvara nešto novo da bi bio preduzetnik, dovoljno je da prepozna i vidi novu šansu ili novi način nastupa na tržištu. Preduzetništvo kao poslovna aktivnost je veoma važna za sva područja društvenog života, pa tako i za sport.

Ključne riječi: Preduzetnik, procesi, menadžment, inovativnost.

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