Montenegrin Journal of Sports Science and Medicine

www.mjssm.me

ISSN 1800-8755

Vol. 6 March 2017 No. 1

Montenegrin Journal of Sports Science and Medicine

Index Coverage
Web of Science Core Collection (Emerging Sources Citation Index); Scopus; Index Copernicus; EBSCO Publishing Inc.; ERIH PLUS; Open Academic Journals Index; Google Scholar; SJIF Scientific journal Impact Factor; SafetyLit; Genamics Journal Seek; Ulrich's; Academic Journals Database; InfoBase; J-Gate; OALib; Global Impact Factor; ROAD; Beardslee Library Journals; UTS: Library; Geisel Guides; Electronic Journal Library; WZB Berlin Social Science Center; Journal Locator; BU Libraries; SMEXE; Journal Impact Factor; CiteFactor; Hinari; Scientific Indexing Services; UNB Libraries; UB Leipzig; SSKS Library; Geisel Library; Dowling College Library; EZB; SHERPA; OUM; Universia; UW-Madison Libraries; Kubon & Sagner; UB Online Library; OCLC World Cat; Impact Factor PL; State Library NSW

Proofreading Service
Terry Troy Jackson

Prepress
Boris Šundić

Print
AP Print | Podgorica

Print Run
1500

CRNOGORSKA SPORTSKA AKADEMIJA • MONTENEGRIN SPORTS ACADEMY •

UCG
Univerzitet Crne Gore

• Fakultet za sport i fizičko vaspitanje • Univerzitet Crne Gore

ISSN 1800-8755 eISSN 1800-8763

MONTENEGRIN JOURNAL OF SPORTS SCIENCE AND MEDICINE

International Scientific Journal

Vol. 6(2017), No.1 (1-98)

TABLE OF CONTENTS

Full-text available free of charge at http://www.mjssm.me/

Dear Readers,

On behalf of the publishing institutions: Montenegrin Sports Academy and Faculty for Sport and Physical Education at University of Montenegro, it is our greatest pleasure to announce an exciting professional move of our journal. The Montenegrin Journal of Sports Science and Medicine (MJSSM) faces the tremendous challenges in last five years. From the first issue, we have been working hard and did many improvements that led us to the great successes such as [1] inclusion in Web of Science Core Collection (since 2015), [2] inclusion in Scopus (since 2016) and highest impact ever by Index Copernicus (ICV 2015: 87.90). Since January 2017, our journal has a new Editorial Team that is selected from recognized experts from the field of Sport Science and will be working within MJSSM next five years to improve its status worldwide as well as solve upcoming challenges and issues in this area. The Montenegrin Sports Academy's Steering Committee have selected them from an interdisciplinary perspective, including social sciences, humanities, natural sciences and medicine. As young Editorial Board members are the future key-players in the Montenegrin Journal of Sports Science and Medicine, the Montenegrin Sports Academy will specifically attract and very warmly welcome highly motivated researchers with strong background from all over the world to become reviewers and board members.

We would also highlight that the Montenegrin Sports Academy will continue working on growing academic publication in the fields of sports science and medicine; all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side, in various formats: original papers, review papers, editorials, short reports, peer review - fair review, as well as invited papers and award papers in two academic journals (MJSSM and Sport Mont), as well as academic books, conference proceedings, brochures etc.

Since this journal has been indexed in Thomson Reuters Core Collection and Scopus in the past period, the volume of submissions has increased dramatically. Consequently, we would like to announce our journal will publish 10 papers per issue in the future, so we would invite potential authors worldwide to take this opportunity and submit their work in order to broaden our knowledge in the area of sport science and medicine.

Thank you for reading us and we hope you will find this issue of MJSSM informative enough.

Editors-in-Chief,
Prof. Dusko Bjelica, PhD
Assist. Prof. Stevo Popovic, PhD

Acute Response of Some Iron Indices of Young Elite Wrestlers to Three Types of Aerobic, Anaerobic, and Wrestling Exercise

Seyed Morteza Tayebi[1], Ali Akbar Mahmoudi[2], Elaheh Shirazi[3] and Maedeh Sangi[4]

Affiliations: [1]Allameh Tabataba'i University, Faculty of Physical Education and Sport Sciences, Tehran, Iran, [2]Sari University of Medical Science, Department of Sport Medicine, Sari, Iran, [3]Shahroud University of Medical Sciences, Shahroud, Iran, [4]Islamic Azad University, Tonekabon Branch, Department of Laboratory Sciences, Tonekabon, Iran

Correspondence: Ali Akbar Mahmoudi, Department of Sport Medicine, Sari University of Medical Science, Sari, Iran. E-mail: aliakbar.1355@gmail.com

ABSTRACT The present study was conducted to investigate the acute responses of some iron indices of young elite wrestlers to three types of aerobic, anaerobic, and wrestling exercises. A total of 24 elite volunteer wrestlers were randomly categorized into three groups (n=8) aerobic, anaerobic, and routine wrestling exercises. The exercises were conducted during three non-consecutive sessions within one week. The aerobic exercises included 35 min of continuous running with 130 beats per minute (BPM) on a treadmill; the anaerobic exercises included 15 min circuit movements and 15 min rest with 160 BPM, and the wrestling training included routine wrestling exercises. Blood sampling was done in the first and third sessions in order to study the acute responses which included four stages of 1 h before, immediately, 3 h, and finally 24 h after exercises. The study of the acute response to the first session showed that the type of exercise had no effect on serum iron (p=0.57). Furthermore, the serum ferritin (p=0.012) and TIBC (p=0.006) affected was affected by type of exercise. The study of the acute response to the second session showed that the type of exercise had no effect on serum ferritin (p=0.731) and TIBC (p=0.231), rather the serum iron was affected by the type of exercise (p=0.01). Conclusively, the study of acute response showed that wrestling exercises led to a decline in iron stores during exercise and reduced total iron binding capacity during a 24-h recovery period. The study of acute exercise after a short adaptation period showed that despite the fact that serum iron had no change in anaerobic and wrestling exercises over the passage of time, it changed during aerobic exercise and 24-h recovery periods. Furthermore, the progress of iron deficiency was only observed in the first stage which prevented its progress to the next stage.

KEY WORDS Iron, Ferritin, Total Iron-Binding Capacity, Aerobic, Anaerobic, Wrestling, Exercise.

@MJSSMontenegro
IRON INDICES OF YOUNG ELITE WRESTLERS IN RESPONSE TO TYPES OF EXERCISE
http://mjssm.me/?sekcija=article&artid=126

Introduction

The metabolic reactions that are active during body activities require special regulators to control heart muscle activity, body contraction, the transmission of nerve impulses, and acid-based balance. The chemical structure of these regulators contains several minerals, including iron, which directly affects body activities (Hinton, Giordano, Brownlie, & Haas, 2000). It seems that body iron status varies due to several factors during the implementation of physical activities and muscle contractions (Sinclair & Hinton, 2005). Karamizrak et al. (1996) reported that the level of iron stores in athletes is about 3% lower than the normal range, which may even reach 50% among women (Karamizrak et al., 1996). Sport haematology has progressed significantly over the last four decades and has become a specific branch of science (Tayebi, Agha Alinejad, Kiadaliri, & Ghorbanalizadeh Ghaziani, 2011). As a phase of sports hematology, iron deficiency is currently one of the most controversial topics in sports medicine (Shaskey & Green, 2000). There are abundant contrary data and conflicting insights in the review of the literature. The key role of iron in oxygen transport makes it a vital

Accepted after revision: June 24 2016 | First published online: March 01 2017

Conflict of interest: None declared.

element for sports performance (DellaValle, 2013; Hinton, 2014). It is also a cofactor for many of the intracellular enzymatic processes engaged in mitochondrial electron transport and oxidative phosphorylation (DellaValle, 2013). Iron deficiency, with or without anaemia, is a common phenomenon in non-sporting communities, and the contradiction initiates when a prevalence comparison is made between public community and athletes. This concern is the most common disease arising from the inadequacy of nutrition around the world, affecting almost 15% of the world population (Beard & Tobin, 2000).

However, the discussion will continue in the field of physical activities and iron status in the body. Studies conducted on iron status concentrated on the comparison between athletes and sedentary people (Sureira, Amancio, & Pellegrini Braga, 2012), the comparison between sport fields (Jackson, 2000; Karamizrak et al., 1996; Schumacher, Schmid, Grathwohl, Bultermann, & Berg, 2002), the examination of athletes during different training seasons (Ostojic & Ahmetovic, 2009), the impact of supplementation and exercises (DellaValle, 2013), the relation between iron status and type of performance (Dellavalle & Haas, 2012), the investigation of the impacts of long-term exercises (Pouramir, Haghshenas, & Sorkhi, 2004), and the effect of exercises on people suffering from thalassemia (Heidary, Bijeh, Hashemi Javahery, & Abrishami, 2011). However, a large gap regarding acute, short-term exercises and anaerobic exercises remain. Milic et al. (2011) reported that athletes who make use of the anaerobic energy system, as compared to the ones who depend on the semi-aerobic anaerobic energy system, possessed higher levels of serum iron and transferrin saturation (Milic, Martinovic, Dopsaj, & Dopsaj, 2011). The aerobic athletes had the highest range of reticulocyte hemoglobin content in comparison to anaerobic and semi-aerobic anaerobic athletes (Milic et al., 2011).

In contrast, wrestling is a sport that requires high anaerobic power, high anaerobic capacity, high muscular endurance, higher than average aerobic power, average pulmonary function, flexibility, a high level of leanness except heavy weights, and a somatotype focusing on mesomorph in a way that diverse exercise methods including anaerobic, endurance, and resistive exercises have been recommended to improve the general physiological profile of wrestlers (Horswill, 1992). Since one of the most important roles of iron is the preservation of acid-based balance (Hinton, 2014), and the acid lactic is the dominant system in this context, the investigation of iron status among wrestlers is a prominent issue. Several studies have been done concerning the iron status of wrestlers. Saygin (2014) compared some parameters of iron status in wrestlers of different weights and reported that serum iron and ferritin among light weight wrestlers are lower than average weight one and the serum ferritin of light-weight wrestlers is lower than that in heavy-weight ones; however, serum total iron binding capacity (TIBC) level has no difference (Saygin, 2014). The comparison between serum ferritin of wrestlers concerning diverse studies showed that there exists no difference, and they are not even influenced by rapid weight loss (Fogelholm et al., 1992; Fogelholm, Koskinen, Laakso, Rankinen, & Ruokonen, 1993; Jackson, 2000; Karamizrak et al., 1996). Hesar Koushki et al. (2013) reported the results of the study on 65 min of wrestling exercises, which showed that red cell distribution width (RDW) as one of the iron status factors was significantly decreased. This reduction was greater in afternoon exercises as compared to morning cycle. However, other iron indices such as haemoglobin and mean cell volume (MCV) had no significant change (Hesar Koushki, Mollanovruzi, & Rashidlamir, 2013).

It is reported that athletes who practice types of sport requiring diverse dominant energy systems demonstrate differences in hematological profile parameters, especially iron indices (Milic et al., 2011). Such differences may result from training for specific disciplines, sport acute effects, seasonal adaptations, and special training regimes such as endurance or strength types (Banfi et al., 2006; Di Santolo, Stel, Banfi, Gonano, & Cauci, 2008; Dopsaj, Sumarac, Novakovic, & Dopsaj, 2008; Schumacher et al., 2000). Considering the insufficient volume of studies performed on athletes' iron status, the results' contradiction and absence of adequate information about anaerobic exercises, and the effect of acute and short-term response on iron status responses, we decided to study the acute responses of some elite wrestlers' iron indices to three types of aerobic, anaerobic, and wrestling exercises.

Methods

Sample

Twenty-four elite volunteer wrestlers with 70±10 kg weight averages, 20±3 years ages, with a record of at least five years of wrestling exercises, and three wrestling exercise sessions per week. They participated in this field research on the condition of acquaintance with all the necessary research conditions, filling out a consent form, possessing physical health status, no severe anaemia, no usage of iron supplement pills, and medicines affecting iron metabolism. They were randomly categorized into three 8-people groups of aerobic, anaerobic, and routine wrestling exercises. The subjects' specifications are summarized in Table 1.

TABLE 1 Demographic characteristics of elite young wrestlers

Variable / Groups	Age (year)	Weight (kg)	Height (m)	BMI (kg/m^2)	BF (%)
Aerobic	17.62±0.94	72.87±4.33	1.73±0.02	24.05±0.87	15.75±0.64
Anaerobic	18.75±0.81	71.12±4.01	1.72±0.03	23.65±0.62	14.37±0.59
Wrestling	18.25±0.97	72.25±3.95	1.73±0.01	23.95±0.80	14.62±0.73

Legend: BMI - Body Mass Index, BF - Body Fat.

UDC 796.81:612.126

Protocol

The subjects participated in two sessions of public instruction classes to become familiar with the procedures. The exercises were conducted within a week during three con-consecutive sessions. Aerobic exercise included 35 min of continuous running with 130 beats per minute (BPM) on a treadmill (Fitness Vision, Taiwan); anaerobic exercises included 15 min circuit exercises, 15 min rest with 160 BPM, and wrestling exercises included routine wrestling exercises (warm up (20-30 min), techniques range (with resistance 50-90%, 30-45 min), 1-2 competition with champion style, cool down (20-30 min)). Blood sampling was done in the first and third sessions. Each sampling session included four stages of 1 h before, immediately, three h, and 24 h after exercise conducted in a sitting position and from the brachial vein with vacuum bottles containing EDTA anticoagulant substance and a venoject needle. The samples were taken to the laboratory and were transferred to a -70 ºC freezer after centrifuging and serum separation. Iron measurement was done with an iron kite (Pars Azmoon, Iran), ferritin measurement with a Vitros kite (Ortodiagnosting, America) and the IRMA method, TIBC measurement with a TIBC kite (Pars Azmoon, Iran) and the Magnesium Carbonate Precipitating method.

Statistical methods

The average descriptive statistics and standard error were applied to describe the collected data. The repeated measured analysis of variance was applied to analyse the acute response for the first and third sessions of exercise. The analysis was performed using SPSS at $p<0.05$ of significance level.

Results

To examine the acute response to the type of exercise, the four blood samples of the first session were measured. Its related data is available in Table 2. The level of serum iron with observance of sphericity assumptions and the effect of TIME over was significant ($F_{3,63}=5.53$, $p=0.002$, $\eta^2=0.21$), and it was a linear significance type ($F_{1,21}=11.05$, $p=0.003$, $\eta^2=0.345$); however, the GROUP effect and interaction effect of GROUP × TIME over were not significant (respectively ($F_{2,21}=0.62$, p=0.55, $\eta^2=0.055$) and ($F_{6,63}=0.81$, p=0.57, $\eta^2=0.07$)). In

TABLE 2 Serum Iron Status of Elite Wrestlers in the First Acute Effects of Three Types of Training

		Mean ± SE				Within Group Effects		Between Group Effects
Variables	**Groups**	**60min preTest**	**Immediately postTest**	**180min postTest**	**24h postTest**	**TIME**	**TIME × GROUP**	**GROUP**
Iron (mg/dL)	Aerobic	122.5±9.01	126.87±12.43	121.62±11.49	113.75±9.04	F=5.53 P=0.002**	F=0.812 P=0.565	F=0.616 P=0.55
	Anaerobic	109.25±12.03	108.37±10.91	107.25±12.06	105.12±11.82			
	Wrestling	109.75±10.34	107.37±11.29	105.50±10.34	101.50±8.82			
Ferritin[a] (mg/dL)	Aerobic	68.75±8.82	69.50±8.23	65.50±7.74	69.25±6.69	F=1.64 P=0.213	F=4.757 P=0.012*	F=0.016 P=0.98
	Anaerobic	68.87±16.30	69.00±15.79	67.00±13.84	65.25±11.88			
	Wrestling	75.12±5.97	70.00±6.46	69.37±7.49	65.75±7.49			
TIBC (mg/dL)	Aerobic	337.75±3.35	333.75±3.05	337.87±3.90	340.25±2.55	F=1.83 P=0.15	F=2.61 P=0.025*	F=0.212 P=0.145
	Anaerobic	346.50±2.57	341.25±2.44	347.12±2.80	317.50±2.71			
	Wrestling	340.00±3.24	339.75±5.28	332.50±2.09	342.87±3.44			

Legend: *- Significant level at p<0.05; a - statistics of TIME and TIME × GROUP getting from Multivariate Tests, Roy's Largest Root method.

other words, the type of exercise had no effect on serum iron, but only the acute physical exercise could establish significant changes in a way that it meaningfully (p=0.015) decreased to 7.04 μg/dl within 24 h after exercise. Since the amount of sphericity assumption was not estimated in the analysis of serum ferritin, the Multivariate Tests with Roy's Largest Root were applied, in which the TIME over effect and GROUP effect were insignificant (respectively ($F_{3,19}=1.644$, $p=0.21$, $\eta^2=0.2$) and ($F_{2,21}=0.02$, $p=0.98$, $\eta^2=0.002$)), but the interaction effect of GROUP × TIME over were significant ($F_{3,20}=4.76$, $p=0.012$, $\eta^2=0.42$). In other words, the aerobic and anaerobic exercises groups had similar behaviour and minimal reduction from the beginning until 3 h after exercises, but in the anaerobic group, this reduction continued during 24 h after exercises, although it returned to the basic levels in the aerobic group. Although the wrestlers' exercise group was higher than the two other groups in basic levels, it was identical with the other groups after a level of reduction and had similar behaviour with the anaerobic exercises group at other times. Moreover, the level of serum TIBC with observance of sphericity assumptions and TIME over effect and GROUP effect were insignificant (respectively ($F_{3,63}=1.83$, $p=0.15$, $\eta^2=0.08$) and ($F_{2,21}=1.12$, $p=0.15$, $\eta^2=0.17$)), but the interaction effect of GROUP × TIME over were significant ($F_{6,63}=2.61$, $p=0.025$, $\eta^2=0.2$) and it was a cubic significance type ($F_{2,21}=4.91$, $p=0.018$, $\eta^2=0.32$). In other words, the TIBC changes in the anaerobic and aerobic groups were identical until 3 h after exercise. Although the changes had minimal increase and decrease in these two groups till 24 h after exercise, they were insignificant. In contrast, in the wrestling exercises group and in all the behavioural stages, the changes were contrary to both groups in a way that the TIBC level had no change under the influence

of exercises. However, it had a significant decrease during the first 3 h of recovery, and a significant increase during 24 h as compared to 3 h after exercises, such that it changed to the pre-exercise basic levels.

The four blood sampling measurements of the third session were applied to study the acute response after short-term adaptation to two non-consecutive sessions of three types of exercises, and the related data are available in Table 3. In the level of serum iron with the observance of sphericity assumptions, TIME over effect and GROUP effect were not significant [respectively ($F_{3,63}$=2.83, p=0.08, η^2=0.32) and ($F_{2,21}$=1.47, p=0.25, η^2=0.12)], but the interaction effect of TIME × GROUP were significant ($F_{6,63}$=3.125, p=0.01, η^2=0.23) and it had both linear and cubic significance (respectively ($F_{2,21}$=5.4, p=0.013, η^2=0.34) and ($F_{2,21}$=4.07, p=0.03, η^2=0.28)). This means that serum iron in two groups of anaerobic and wrestling exercises after a short-term adaptation to two con-consecutive sessions and in acute response to one exercise session had a similar descending linear process. However, the aerobic group exercises in the 24 h recovery stage after exercise increased as compared to the hours before, immediately and 3 h after exercise which was precisely contrary to the two other groups. In contrast, the level of serum ferritin with the observance of sphericity assumptions, TIME over effect was significant ($F_{3,63}$=5.1, p=0.003, η^2=0.2) and it was a linear significance ($F_{1,21}$=11.11, p=0.003, η^2=0.346), but the GROUP effect and the interaction effect of TIME × GROUP were not significant (respectively ($F_{2,21}$=2.82, p=0.08, η^2=0.21) and ($F_{6,63}$=0.6, p=0.73, η^2=0.054)]. This means that the type of exercise had no effect on serum ferritin, but only the acute physical exercise after two sessions of short-term adaptation could exert significant changes. This is done in a way that it had significant decline to 6.42 μg/L during 24 h after exercise (p=0.021). Moreover, the level of serum TIBC with observance of sphericity assumption and effect of TIME over, GROUP effect and the interaction effect of TIME × GROUP was not significant (respectively ($F_{3,63}$=1.78, p=0.16, η^2=0.078) ($F_{2,21}$=1.85, p=0.18, η^2=0.15) and ($F_{6,63}$=1.4, p=0.23, η^2=0.12)).

TABLE 3 Serum Iron Status of Elite Wrestlers in Second Acute Effects of Three Types of Training

		Mean ± SE				Within Group Effects		Between Group Effects
Variables	**Groups**	**60min preTest**	**Immediately postTest**	**180min postTest**	**24h postTest**	**TIME**	**TIME × GROUP**	**GROUP**
Iron (mg/dL)	Aerobic	105.12±5.15	107.50±7.72	100.25±7.40	113.62±7.82	F=2.28 P=0.088	F=3.125 P=0.01**	F=1.471 P=0.252
	Anaerobic	114.75±10.09	111.50±10.19	110.37±9.73	105.75±10.83			
	Wrestling	130.62±8.51	125.87±9.26	123.87±8.47	124.00±8.39			
Ferritin (mg/dL)	Aerobic	78.50±3.16	75.50±4.37	75.50±3.16	71.37±4.53	F=5.079 P=0.003**	F=0.597 P=0.731	F=2.819 P=0.082
	Anaerobic	81.62±5.03	79.50±4.51	74.87±3.50	72.50±4.46			
	Wrestling	63.62±7.17	63.50±6.21	62.50±6.51	60.62±6.04			
TIBC (mg/dL)	Aerobic	340.12±3.48	342.37±2.67	343.87±2.70	334.62±3.01	F=1.78 P=0.16	F=1.39 P=0.231	F=1.856 P=0.181
	Anaerobic	337.25±3.40	340.87±3.30	341.12±2.81	343.25±3.82			
	Wrestling	334.50±2.07	339.00±2.54	336.00±2.29	333.75±2.16			

Legend: * - Significant level at p<0.05; ** - Significant level at p<0.01.

Discussion

In the first investigation of acute effect, the one stage of aerobic, anaerobic, and wrestling exercise was observed. The serum iron changes in the effect of TIME over had no difference among the groups. However, the serum ferritin and TIBC changes were significant. This is done in a way that ferritin had a significant change in wrestling exercise, which was different with the two other groups. The aerobic exercise group after the continuous mild decline until 3 h after exercises returned to the baseline levels during 24 h of recovery period which was significantly higher than the two other groups. In contrast, the TIBC level in the wrestling exercise group had no significant change during exercises, but it decreased in the aerobic and anaerobic groups in such a way that it had a significant difference between these two groups. Moreover, the serum TIBC in the exercise group had significant decline within 3 h after exercise, while it increased in aerobic and anaerobic exercise groups and returned to the basic levels and had a significant difference between these two groups. The serum TIBC of the three groups returned to the baseline levels during 24 h after exercise in such a way that its changes difference in effect of TIME over in wrestling group was significant with the two other groups. In contrast, in the study of the acute effect of one stage of aerobic, anaerobic, and wrestling exercises after two non-consecutive sessions from that exercise, there were intergroup differences only in serum iron changes in the effect of TIME over. Therefore, the anaerobic and wrestling exercises had a similar procedure devoid of significant changes. However, its amount had a significant increase in the aerobic exercise group during a 24-h recovery period.

In other words, in the comparison of the acute effects of the three types of exercise, the serum iron in the three types of exercise successively decreased the effect of TIME over even if there was no difference among the methods. The wrestling exercises led to a significant decline in iron stores during exercises and the decline in TIBC in recovery period within 24 h after exercises. The aerobic and anaerobic exercises were not in this

situation, and these two types of exercises had similar behaviours. Furthermore, after a short time adaptation to two non-consecutive sessions from the three types of aerobic, anaerobic, and wrestling exercises, the acute effect of these three types of exercises was different from the initial acute effect. The descending process of serum iron in two anaerobic and wrestling groups was similar and identical, but it had a significant increase to the top level of initial levels in the aerobic method in recovery period within 24 h after exercises. The iron stores had continuous decline in the effect of TIME over with no difference in the type of exercises. It was determined that the type of machine supplying specific sport energy creates a different effect in the hematologic profile and iron indices (Milic et al., 2011) which resulted from training for specific disciplines, sport acute effect, seasonal adaptations, and special training regimes, such as endurance or strength training (Banfi et al., 2006; Di Santolo et al., 2008; Dopsaj et al., 2008; Schumacher et al., 2000).

Millic et al. (2011) reported that the athletes who apply anaerobic energy system had a higher level of serum iron and transferrin saturation as compared to athletes engaged in semi-aerobic anaerobic energy system. Furthermore, athletes practicing aerobic exercises possess the highest level of reticulocyte haemoglobin content as compared to anaerobic and semi-aerobic anaerobic systems (Milic et al., 2011).

The present study showed that in the short-term adaptation to two exercise sessions, the serum iron of wrestlers who had practiced aerobic exercises was significantly lower than those practicing anaerobic and wrestling exercise. In contrast, the serum ferritin of wrestlers who practiced aerobic and anaerobic exercises was higher than that of wrestlers who practiced wrestling exercises. The iron indices of elite wrestlers in short-term adaptation to three sessions had no difference in any of the exercise types.

The iron, TIBC, and ferritin levels are among the oldest biomarkers to examine the athletes during the training season (Fallon, 2008). Iron deficiency may have a negative effect on oxygen transport and immune defence and thus affects the sports performance (Peeling, Dawson, Goodman, Landers, & Trinder, 2008).

Iron deficiency progresses in three stages (World Health Organization & Centers for Disease Control and Prevention, 2007). Firstly, the iron stores in reticuloendothelial cells of the liver, spleen, and bone marrow decline, which is seen as a reduction in serum ferritin and is introduced as reduced iron stores. The second stage is demonstrated with red blood cell production (erythropoiesis) followed by a reduction in iron transport and iron preparation for cells. This stage is manifested by low serum iron, increased total binding capacity, and reduced transferrin saturation. These two stages of iron deficiency are introduced as "latent iron deficiency" pre-anaemia or "iron-deficient non-anaemia". In the last stage of iron deficiency, the haemoglobin synthesis reduces due to the insufficient preparation of iron which leads to anaemia (World Health Organization & Centers for Disease Control and Prevention, 2007). In other words, the present study and the first acute effect study showed that the first stage of iron deficiency was observed during wrestling exercises and the second stage was in the recovery period within 24 h after exercises. In the investigation of the second acute effect, all the three types of exercises led to the first stage of iron deficiency. Rahmaninia et al. (2015) observed that the serum ferritin level decreased to 16% after one session of the Bruce test which reached 7.4% after five rest days and conduction of the second Bruce test (Rahmaninia, Damirchi, & Masoumi, 2005). Malczewska et al. (2000) reported that the serum ferritin increase is observed within three to four days after a hard workout (Malczewska, Bach, & Stupnicki, 2000).

The major mechanism of exercise-related iron loss in athletes includes haemolysis, haematuria, sweating, gastrointestinal bleeding, and chronic inflammation. The latest reports showed that hepcidin, a peptide hormone regulating iron, which is primarily formed in the liver, can organize the plasma concentrations of iron in response to inflammations (Peeling et al., 2009). Hepcidin regulates the iron concentration and distribution of tissue iron through the inhibition of intestinal absorption, release by macrophages, and mobilization of hepatic iron reserves (E. H. J. M. Kemna, Tjalsma, Willems, & Swinkels, 2008). Hepcidin levels increase from 3 to 24 h after exercise in response to interleukin-6 (IL-6), an initial regulating cytokine for hepcidine up-regulation which rapidly decreases the concentration of iron plasma (E. Kemna, Pickkers, Nemeth, van der Hoeven, & Swinkels, 2005; Nemeth et al., 2004; Peeling, 2010; Peeling et al., 2014). It was determined that acute exercise sessions increase the acute phase response and lead to the production of post-exercise cytokines (Nunes, Grotto, Brenzikofer, & Macedo, 2014). It is known that IL-6 derived from muscle as compared to its previous status, can increase up to 100 times during training (Petersen & Pedersen, 2005). Peeling et al. (2014) observed that after one session of acute running exercise with four diverse protocols in four groups possessing different levels of ferritin (lower than 30, 30-50, 50-100, and above 100), the serum ferritin, except in groups lower than 30 had significant increases (Peeling et al., 2014). The serum iron in all the groups except 30-50 group had a significant increase (Peeling et al., 2014). The IL-6 had a significant increase in all the groups (Peeling et al., 2014). Moreover, within 3 h after exercises, hepcidine-25 had a behaviour similar to post-exercise serum ferritin such that a strong, positive, and significant correlation was observed between these two groups (Peeling et al., 2014). Auersperger et al. (2013) reported that 71% of iron stores (serum ferritin) after eight weeks of long-term running had a long-term decrease (serum ferritin) (Auersperger et al., 2013). They were even not recovered over a 10-day recovery period and were still at a high level of 67% (Auersperger et al., 2013). Hepcidine had a behaviour similar to serum ferritin (Auersperger et al., 2013). Moreover, the serum TIBC and iron decreased due to the 8-week exercise period and had not changed in the recovery period (Auersperger et al., 2013). The present study did not investigate these mechanisms; however, the probability of their influence can be brought forth for discussion.

Conclusion

The present study showed that the three types of aerobic, anaerobic, and wrestling exercises had different acute effects on the iron indices of elite wrestlers in a way that wrestling exercises led to a decline in iron stores during exercise (the first stage of iron deficiency), decline in total iron-binding capacity during exercise (the second stage of iron deficiency), and during a 24-h recovery period. Moreover, even if these three types of acute exercises are studied after a short-term adaptation period, they probably will create different responses on the iron indices of elite wrestlers. The serum iron had no change in anaerobic and wrestling exercises over the passage of time, but it increased in aerobic and 24-h recovery periods. Furthermore, the iron deficiency only progresses in the first stage (serum ferritin decline in time passage with no impact of intergroup differences) and avoids its progress to the next stage (no TIBC change). It may be concluded that short-term aerobic training can cause positive adaptation of iron indices of elite wrestlers; the role of aerobic power in recovery from the acute effect of exercise in wrestlers has been proved.

Furthermore, serum TIBC had no significant changes in aerobic and anaerobic exercises in both study designs. It had a significant decrease in the wrestling exercise of the first study design in the 3 h recovery period that returned to baseline after 24 h. This may mean that it may be a recovery-dependent iron index. Therefore, it is recommended that elite wrestlers pay much attention to the type of field-specific training and related compatibilities in their workout schedule to avoid any exposure to iron deficiency, probable damage to their sports performance, and that they benefit from profitable recovery and nutrition plans. It is suggested that the effect of long-term adaptation to these exercises on acute responses be studied, and the nutrition status be recorded during any subsequent study.

REFERENCES

Auersperger, I., Škof, B., Leskošek, B., Knap, B., Jerin, A., & Lainscak, M. (2013). Exercise-Induced Changes in Iron Status and Hepcidin Response in Female Runners. *PLoS ONE, 8*(3), e58090. doi: 10.1371/journal.pone.0058090

Banfi, G., Mauri, C., Morelli, B., Di Gaetano, N., Malgeri, U., & Melegati, G. (2006). Reticulocyte count, mean reticulocyte volume, immature reticulocyte fraction, and mean sphered cell volume in elite athletes: reference values and comparison with the general population. *Clin Chem Lab Med, 44*(5), 616-622. doi: 10.1515/cclm.2006.094

Beard, J., & Tobin, B. (2000). Iron status and exercise. *The American Journal of Clinical Nutrition, 72*(2), 594s-597s.

DellaValle, D. M. (2013). Iron supplementation for female athletes: effects on iron status and performance outcomes. *Curr Sports Med Rep, 12*(4), 234-239. doi: 10.1249/JSR. 0b013e31829a6f6b

Dellavalle, D. M., & Haas, J. D. (2012). Iron status is associated with endurance performance and training in female rowers. *Med Sci Sports Exerc, 44*(8), 1552-1559. doi: 10. 1249/MSS.0b013e3182517ceb

Di Santolo, M., Stel, G., Banfi, G., Gonano, F., & Cauci, S. (2008). Anemia and iron status in young fertile non-professional female athletes. *Eur J Appl Physiol, 102*(6), 703-709. doi: 10.1007/s00421-007-0647-9

Dopsaj, V., Sumarac, Z., Novakovic, N., & Dopsaj, M. (2008). Determination of parameters of iron status in evaluation of anemia in elite young Serbian water polo players. *Serb J Sports Sci, 2*(1-4), 91-99.

Fallon, K. E. (2008). The clinical utility of screening of biochemical parameters in elite athletes: analysis of 100 cases. *Br J Sports Med, 42*(5), 334-337. doi: 10.1136/bjsm.2007. 041137

Fogelholm, G. M., Himberg, J. J., Alopaeus, K., Gref, C. G., Laakso, J. T., Lehto, J. J., & Mussalo-Rauhamaa, H. (1992). Dietary and biochemical indices of nutritional status in male athletes and controls. *Journal of the American College of Nutrition, 11*(2), 181-191.

Fogelholm, G. M., Koskinen, R., Laakso, J., Rankinen, T., & Ruokonen, I. (1993). Gradual and rapid weight loss: effects on nutrition and performance in male athletes. *Med Sci Sports Exerc, 25*(3), 371-377.

Heidary, H., Bijeh, N., Hashemi Javahery, S. A. A., & Abrishami, F. (2011). The Effect Of Eight Weeks Of Aerobic Training On Hematological Indices In B-Thalassemia Minor Patients In Kermanshah. *Ofogh-E-Danesh, 17*(3), 20-27 [Article in Farsi].

Hesar Koushki, M., Mollanovruzi, A., & Rashidlamir, A. (2013). The Effect of Wrestling Exercise in Morning and AftThe Effect of Wrestling Exercise in Morning and Afternoon on Some Hematological Indices. *International Journal of Applied Exercise Physiology, 2*(1), 11-17.

Hinton, P. S. (2014). Iron and the endurance athlete. *Applied Physiology, Nutrition, and Metabolism, 39*(9), 1012-1018. doi: 10.1139/apnm-2014-0147

Hinton, P. S., Giordano, C., Brownlie, T., & Haas, J. D. (2000). Iron supplementation improves endurance after training in iron-depleted, nonanemic women. *Journal of Applied Physiology, 88*(3), 1103-1111.

Horswill, C. A. (1992). Applied physiology of amateur wrestling. *Sports Med, 14*(2), 114-143.

Jackson, C. G. R. (2000). *Nutrition and the Strength Athlete*: CRC Press.

Karamizrak, S. O., Işlegen, C., Varol, S. R., Taşkiran, Y., Yaman, C., Mutaf, I., & Akgün, N. (1996). Evaluation of iron metabolism indices and their relation with physical work capacity in athletes. *Br J Sports Med, 30*(1), 15-19. doi: 10.1136/bjsm.30.1.15

Kemna, E., Pickkers, P., Nemeth, E., van der Hoeven, H., & Swinkels, D. (2005). Time-course analysis of hepcidin, serum iron, and plasma cytokine levels in humans injected with LPS. *Blood, 106*(5), 1864-1866.

UDC 796.81:612.126

doi: 10.1182/blood-2005-03-1159

Kemna, E. H. J. M., Tjalsma, H., Willems, H. L., & Swinkels, D. W. (2008). Hepcidin: from discovery to differential diagnosis. *Haematologica, 93*(1), 90-97. doi: 10.3324/haematol.11705

Malczewska, J., Bach, W., & Stupnicki, R. (2000). The Effects of Physical Exercise on the Concentrations of Ferritin and Transferrin Receptor in Plasma of Female Judoists. *Int J Sports Med, 21*(03), 175-179. doi: 10.1055/s-2000-299

Milic, R., Martinovic, J., Dopsaj, M., & Dopsaj, V. (2011). Haematological and iron-related parameters in male and female athletes according to different metabolic energy demands. *Eur J Appl Physiol, 111*(3), 449-458. doi: 10. 1007/s00421-010-1656-7

Nemeth, E., Rivera, S., Gabayan, V., Keller, C., Taudorf, S., Pedersen, B. K., & Ganz, T. (2004). IL-6 mediates hypoferremia of inflammation by inducing the synthesis of the iron regulatory hormone hepcidin. *J Clin Invest, 113*(9), 1271-1276. doi: 10.1172/jci20945

Nunes, L. A. S., Grotto, H. Z. W., Brenzikofer, R., & Macedo, D. V. (2014). Hematological and Biochemical Markers of Iron Status in a Male, Young, Physically Active Population. *BioMed Research International, 2014*, 7. doi: 10.1155/ 2014/349182

Ostojic, S. M., & Ahmetovic, Z. (2009). Indicators of iron status in elite soccer players during the sports season. *International Journal of Laboratory Hematology, 31*(4), 447-452. doi: 10.1111/j.1751-553X.2008.01064.x

Peeling, P. (2010). Exercise as a mediator of hepcidin activity in athletes. *Eur J Appl Physiol, 110*(5), 877-883. doi: 10.1007/s00421-010-1594-4

Peeling, P., Dawson, B., Goodman, C., Landers, G., & Trinder, D. (2008). Athletic induced iron deficiency: new insights into the role of inflammation, cytokines and hormones. *European Journal of Applied Physiology, 103*(4), 381-391. doi: 10.1007/s00421-008-0726-6

Peeling, P., Dawson, B., Goodman, C., Landers, G., Wiegerinck, E. T., Swinkels, D. W., & Trinder, D. (2009). Effects of exercise on hepcidin response and iron metabolism during recovery. *Int J Sport Nutr Exerc Metab, 19*(6), 583-597.

Peeling, P., Sim, M., Badenhorst, C. E., Dawson, B., Govus, A. D., Abbiss, C. R., . . . Trinder, D. (2014). Iron Status and the Acute Post-Exercise Hepcidin Response in Athletes. *PLoS ONE, 9*(3), e93002. doi: 10.1371/ journal.pone. 0093002

Petersen, A. M., & Pedersen, B. K. (2005). The anti-inflammatory effect of exercise. *J Appl Physiol (1985), 98*(4), 1154-1162. doi: 10.1152/japplphysiol.00164.2004

Pouramir, M., Haghshenas, O., & Sorkhi, H. (2004). Effects of gymnastic exercise on the body iron status and hematologic profile. *Iran J Med Sci, 29*(3), 140-141.

Rahmaninia, F., Damirchi, A. R., & Masoumi, S. (2005). The Comparison Of Effects Of Two Types Of Physical Activity On Iron Status And Serum Ferritin And Soluble Transferrin Receptor In Athletes. *Olympic, 13*(2), 23-33 [Article in Farsi].

Saygin, O. (2014). Examination of Some Physical, Hematological Parameters and Iron Status of Greco-Roman Wrestlers in the Age Category of Cadets by Weight Classes. *Anthropologist, 18*(2), 325-334.

Schumacher, Y. O., Grathwohl, D., Barturen, J. M., Wollenweber, M., Heinrich, L., Schmid, A., . . . Keul, J. (2000). Haemoglobin, haematocrit and red blood cell indices in elite cyclists. Are the control values for blood testing valid? *Int J Sports Med, 21*(5), 380-385. doi: 10.1055/s-2000-3785

Schumacher, Y. O., Schmid, A., Grathwohl, D., Bultermann, D., & Berg, A. (2002). Hematological indices and iron status in athletes of various sports and performances. *Med Sci Sports Exerc, 34*(5), 869-875.

Shaskey, D. J., & Green, G. A. (2000). Sports haematology. *Sports Med, 29*(1), 27-38.

Sinclair, L. M., & Hinton, P. S. (2005). Prevalence of Iron Deficiency with and without Anemia in Recreationally Active Men and Women. *Journal of the American Dietetic Association, 105*(6), 975-978. doi: http://dx.doi.org/10.1016/ j.jada.2005.03.005

Sureira, T. M., Amancio, O. S., & Pellegrini Braga, J. A. (2012). Influence of artistic gymnastics on iron nutritional status and exercise-induced hemolysis in female athletes. *Int J Sport Nutr Exerc Metab, 22*(4), 243-250.

Tayebi, M., Agha Alinejad, H., Kiadaliri, K., & Ghorbanalizadeh Ghaziani, F. (2011). Assessment of CBC in physical activity and sport: a brief review. *Sci J Blood Transfus Organ, 7*(4), 249-265[Article in Farsi].

World Health Organization, & Centers for Disease Control and Prevention. (2007). *Assessing the iron status of populations* (Second ed.). Geneva, Switzeland: WHO Press.

ORIGINAL SCIENTIFIC PAPER

Comparison of Psychological Skills, Athlete's Identity, and Habits of Physical Exercise of Students of Faculties of Sport in Four Balkan Countries

Joško Sindik[1], Gordana Furjan-Mandić[2], Nataša Zenić[3], Ivana Čerkez Zovko[4], Veroljub Stanković[5], Zvezdan Savić[6], Zoran Djokić[7] and Miran Kondrič[8,9]

Affiliations: [1]Institute for Anthropological Research, Zagreb, Croatia, [2]University of Zagreb, Faculty of Kinesiology, Zagreb, Croatia, [3]University of Split, Faculty of Kinesiology, Zagreb, Croatia, [4]University of Mostar, Faculty of Science and Education, Mostar, Bosnia and Herzegovina, [5]University of Prishtina, Faculty of Sport and Physical Education, Leposavic, Serbia, [6]University of Nis, Faculty of Sport and Physical Education, Nis, Serbia, [7]University of EDUCONS, Faculty of Sport and Tourism, Novi Sad, Serbia, [8]University of Ljubljana, Faculty of Sport, Ljubljana, Slovenia, [9]International Table Tennis Federation, Lausanne, Switzerland

Correspondence: Joško Sindik, Institute for Anthropological Research, Gajeva 32/2, 10000 Zagreb, Croatia. E-mail: josko.sindik@inantro.hr

ABSTRACT The goals of the research were to determine the construct validity and reliability of two psychological instruments (AIMS) and (PSICA) applied on samples of college sport students; the correlations between the students' competition rank, years of engaging in sport, and level of physical exercise; the differences among the universities in different countries, as well as among students from different years of study. The stratified sample included students from six universities, in total 1498 female and male college sport students, with an average age of 20.35±1.76 years (males) and 20.14±1.55 years (females). Both psychological measuring instruments showed very satisfactory psychometric properties. Reliability is particularly high for males for AIMS, while the reliabilities for PSICA are mainly moderate to high and lower than for AIMS. The results could be explained in terms of cultural and organizational differences, and provide the information about directions in designing efficient programs for physical exercise.

KEY WORDS Physical Activity, Psychology, Sport, Gender, Health.

Introduction

There are few studies about physical exercise and related psychological concepts in the countries of the ex-Yugoslavia, which are conducted on sport students and their sport-related behaviours (Furjan-Mandić, Kondrič M., Tušak, Rausavljević & Kondrič L., 2010; Kondrič, Furjan-Mandić & Munivrana, 2011; Kondrič, Sindik, Furjan-Mandić & Schiefler, 2013; Sindik, Furjan-Mandić, Schiefler & Kondrič, 2013). Therefore, the main issue of this article is to compare the level of physical exercise and two psychological concepts, between six universities in four countries that were part the ex-Yugoslavia.

The organization of sport in EU and ex-Yugoslavia countries

The organization of sport in the EU countries on the national level varies from state to state, but the so-called organized sport pyramid model is common for the world, including Europe. The pyramid structure of the organization reflects a system in which the subjects in the area of one sport join in regional, then national, and finally, in the European and international (world) federation. The foundation of the pyramid are sports clubs that allow everyone to be involved in sport, and thereby promote the idea of sport for all (White Paper on Sport, 2007).

Accepted after revision: June 30 2016 | First published online: March 01 2017

Conflict of interest: None declared.

The Treaty of Amsterdam, signed in 1997, included a Declaration on Sport, which emphasizes the social importance of sport and its role as the origin of identity and bringing people together and calls for broader cooperation between the Community institutions and the sports movement (Amsterdam Declaration on Sport, 1997). The Treaty of Nice (2000) also contained a declaration on the specific characteristics of sport, which highlights its significant social, educational, and cultural functions (Nice Declaration on Sport, 2000).

In 2007, the European Commission developed and adopted a White Paper on Sport (White Paper on Sport, 2007), the most comprehensive document on sport, which aims to define its role in the EU, recognizing its importance for social and economic development. It states that sports organizations should have autonomy, and it recognizes the specific role of sport, but within the European competition law. The White Paper proposes the implementation of the Action Plan Pierre de Coubertin, outlining the social and economic aspects of sport, such as public health, education, social inclusion, and the financing of sport. In addition to the White Paper on Sport, the EU has adopted a number of analytical and policy documents for different areas of sport over the years.

However, countries within and outside the EU have different legal solutions in certain specific areas, such as the financing of sport, but also physical (sport) education in schools, violence in sports arenas, doping, etc.

After the breakup of Yugoslavia, each of the former Yugoslav republics started its own path to the identity formation of newly independent states. Although each new country has its own objectives in the formation of their national identity, the roots, and heritage of the coexistence in the former joint country are reflected in a number of socio-economic areas. One of them is the establishment of sports identity, both in terms of competition, as well as recreational. In order to raise awareness about the importance of physical exercise, it is certainly important to invest in infrastructure (sports halls and courts, fitness centres, school sports hall), but also the establishment of new sports colleges.

Research conducted in European countries showed that countries with the highest standard have the largest shares of consumption of sport recreation in total personal consumption (for example, Sweden 2.2%, Ireland 1.9% United Kingdom 1.7%), while countries with lower living standard generally have lower shares (for example, Slovakia 0.51%, Croatia 0.47%, Hungary 0.44%).

The share of the total funding of sport in GDP in Slovenia and Croatia was below 1% (Andreff, 2006; Škorić, Bartoluci & Čustonja, 2012). Slovenian tax legislation indirectly contributes to the financing of sport. Activities associated with the sport are taxed at a reduced VAT rate of 8%. A reduced rate of 8.5% applies to tickets for sporting events or the use of sports infrastructure (Jurak, Andreff, Popović, Jakšić & Bednarik, 2014).

Athletic identity and psychological skills

As university society continues to emphasize sport, many students around the world are developing a better understanding of participation in sports activities. Once a student is involved in any sports activity, he/she will experience a process of sport socialization.

In literature, some social psychological theories that could provide additional information on which factors should be included or excluded in an athletic identity model can be found (Stryker & Burke, 2000; Visek, Hurst, Maxwell & Watson, 2008; Whipple, 2009). According to Brewer, Van Raalte and Linder (1993), athletic identity has been defined as the degree of strength and exclusivity to which a person identifies him/herself with the athletic role.

Therefore, students often focus on only one aspect of their personality and neglect the salience of other identities (e.g. partner relation, friendship, academic career, family, etc.). University students develop a variety of identities, because they are involved in several social networks. However, this strong involvement can cause a lack of participation in other activities, such as sports activities: identity foreclosure (Whipple, 2009). "Identity foreclosure is a construct used to describe people who have committed to an occupation or an ideology without first engaging in exploratory behaviour" (Good, Brewer, Petitpas, Van Raalte & Mahar, 1993, p. 2). Lally and Kerr (2005) determined that student athletes may invest in both the sports and the students' role identities simultaneously. Miller and Kerr (2002, 2003) also reported that sport students pass through multiple stages of identity. These authors observed that students in the first two years of study were more committed to their athletic roles, but changed their approach in the next two years to academic roles to prepare themselves for future careers. Gaston-Gayles (2004) examined academic and athletic motivations and how these impacted academic performance in student athletes. This study found that the pursuit of a professional athletic career does not impact academic success. Changes in students' self-determined motivation and goal orientation are mostly directed toward increasing task-involvement during physical activity (Yopyk & Prentice, 2005; Jaakkola & Liukkonen, 2006; Proios M., Proios M.C., Mavrovouniotis, & Theofanis, 2012).

Research on students' sports performance and their physical condition remains in its relative infancy, although students are beginning to realize the importance of the mental aspects of sport. However, a number of studies that suggest that various psychological skills contribute to active engagement in sport activities among students can be found (Moreno, Lopez de San Roman Blanco, Martinez Galindo, Alonso Villodre & Gonzales-Cutre Coll, 2008; Moreno, Gonzales-CutreMartin-Albo & Cervello, 2010; Egli, Bland, Melton

& Czech, 2011; Verloigne et al., 2011; Kondrič et al., 2013; Sindik et al., 2013). The Psychological Skills Inventory for Sports (PSIS R-5; Mahoney, Gabriel, & Perkins, 1987) contains 51 items designed to measure six psychological skills related to sports performance, which has been used in its various forms by a number of investigators in many studies at different levels of sport: from sports for all to high-level sport (Spieler, 2006; Elferink-Gemser, Visscher & Lemmink, 2008; Ebben & Gagnon, 2012; Sindik, 2014). Mahoney (1989) later modified the instrument, which became known as the PSIS R-5, with 45 Likert-scale items.

In most research throughout the world, a key issue in physical activity is developing an understanding of motivation, as one of the psychological skills (Buckworth & Nigg, 2004; Kilpatrick, Hebert & Bartholomew, 2005; Ebben & Brudzynski, 2008; Afsanepurak, Seyed Hossini, Seyfari & Fathi, 2012; Kondrič et al., 2013; van Heerden, 2014). The value of participation in sport and the great potential future that sport has in college education should be presented to these students to increase interest and motivation in their efforts for healthier lives. This may also increase the intrinsic motivation among students. If motivation is not addressed and countered, students may cease further participation in sport (van Heerden, 2014). The most commonly reported reasons by many researchers throughout the world for the college students' non-participation were insufficient time due to study or additional work to earn some money for their living expenses. Conversely, the same researchers report that health and fitness were more commonly indicated as the main reasons for participating by those students who participated regularly compared with those who did so on a less regular basis (Kolar et al., 2009; Kondrič et al., 2013; Turkmen, 2013).

Importance of regular physical activity

Daily physical activity on a moderate basis is not recommended only for young people but for people of all ages. Many studies have shown that young people are not as physically active as they need to be (Fang, 2007; Goudas & Hassandra, 2006; Lutz et al., 2008; Strel & Sila, 2010; Kondrič et al., 2013). Nowadays, there is increasing pressure and stress on students, but physical activity among students has been found to reduce stress and depression (Morgan, 1994; Shashank et al., 2013). Increasing physical activity in the college-aged population is a priority for every government. Better scientific approaches are needed to investigate how required health and physical education courses can increase students' physical activity. College students are particularly prone to sedentary lifestyles because of the transitional nature of college life (especially freshmen), which is quite different from the life of middle school students (Buckworth & Nigg, 2004; Melendez, 2006; Fountaine et al., 2011). Students' time being physically active students might be influenced by their ability to effectively cope with study responsibilities, increased workload and change of eating and sleeping habits (Carney et al., 2006; Bobek & Caldwell, 2007). Woodruff and Schallert (2008) described the relationship between motivation and the self within the domains of academics and athletics as a motivational sense of self.

Although there are thousands of clear benefits of a sports active lifestyle, in the college population significant health problems because of lack of physical activity continue to occur. Some studies investigating the physical activity behaviours in college students found approximately 35% to 42% of students fail to obtain the recommended amount of physical activity (Miller, Staten, Rayens, & Nolan, 2005; Racette, Deusinger, Strube, Highstein, & Deusinger, 2008). Given this observation, we would expect participation in physical activity to be the norm in college students. However, some epidemiological studies indicate that globally there is a problem of declining of physical activity, especially in the transition from high school to college (Van Dyck et al., 2015). Physical activity participation statistics indicate a significant decline in physical activity in the 18-24-year-old age group (Caspersen, Pereira & Curran, 2000). The physical activity of high school students appears to be higher than that of college students (Kilpatrick, Herbert & Bartholomew, 2005; Judge et al., 2012).

The benefits of a physically active lifestyle among college students are well documented and can lead to improvements in their physiological and psychological health. In a study on relationships between body mass and body image and relative autonomy for exercise Markland and Ingledew (2007) found that introjected, identified, and intrinsic regulation were positively related to exercise behaviour in adolescents. However, motivation was negatively related to their exercise behaviour. According to the authors, it could be important to enhance more autonomous types of motivation to increase continuous participation in college students. To maintain health, the American College of Sports Medicine and the American Heart Association recommend engaging in at least 30 minutes of moderate-intensity aerobic physical activity five or more days per week, or 20 minutes of vigorous-intensity aerobic physical activity three or more days per week, or a combination of the two (Haskell et al., 2007).

The choices students make how to spend their free time influence their level of physical activity, and there are various factors that influence those choices. The problems and situations encountered by the college students in their need to be physically active may differ from place to place. The places where college students live are quite different and not every city/country has enough sports facilities that could give students the possibility to be involved in sport. Particularly among freshmen, there is an enormous pressure to earn good grades and be successful in their studies. However, this is not the only source of stress, since students increasingly need to earn some money for their daily living expenses, in addition to the heavy demands of their studies (Browder, 2001). Physical inactivity has also been consistently associated with the risk of different chronic diseases and health problems, foremost among which is obesity (Keating et al., 2005; Taras, 2005; Pauline, 2013). Even

though much research has been conducted, it remains unclear whether sedentary behaviour leads to the risks of physical inactivity.

Exercise and physical activity have been described in many studies; however, there are few studies in the countries of the former Yugoslavia (Majerič & Markelj, 2009; Furjan-Mandič et al., 2010; Kondrič et al., 2011; Kondrič et al., 2013; Sindik et al., 2013) that have dealt with this topic related to sport students and their study behaviours. In the research of Kondrič et al. (2013) the results revealed the latent structure of the types of sport students' motives consisted of six factors (sport action with friend, popularity, fitness & health, social status, sports events, relaxation through sports). They also found significant sex differences in the motivation to participate in sport activities for all sport students from the three different countries. Results in the research of Majerič and Markelj (2009) revealed that sport is one of the most common extracurricular activities of students, which is also appreciated as an important value in life. Interestingly, Sindik and Vojinović (2012) determined that there are no differences between male and female students of kinesiology in relation to the current ways of using free time, preferred ways to spend winter/summer holidays, wishes for learning new sport activities, and the preferred ways of using free time. Gadžić and Vučković (2009) reported that approximately 23% of secondary school students from central Serbia were actively engaged in sports at various levels: local (11%), regional (8%), national (3%), the others were classified as sedentary. The sport-active subjects scored significantly higher sociometric acceptance and sociometric status and lower sociometric rejection than the sedentary ones. However, no significant correlations were found between sport-engagement variables and the sociometric ones. Interesting results are seen in the work of Mihajlovic et al. (2010) as they conclude that the prevalent number of students, regardless of the faculty which they belong, rarely volunteered in areas outside of sport.

Therefore, the focus of this study was to examine and analyse the level of physical activity of college sport students among four countries in ex-Yugoslavia, together with their athletic identity and psychological skills. We conducted separate analysis for male and female students, as well as for two age groups. In some previous studies, different researchers found significant gender and age differences (Wallace et al., 2000; Wallace & Buckworth, 2001; Killpatrick, Hebert & Bartholomew, 2005; Bobek & Caldwell, 2007; Egli et al., 2011).

The first goal of this research was to determine the construct validity and reliability of two psychological instruments (measuring sport identity and basic psychological skills for athletes), applied on the samples of male and female college sport students in four Balkan countries: Athletic Identity Measurement Scale (AIMS) and Psychological Skills Inventory for Chinese Athletes (PSICA).

The second goal was to determine the correlations between the students' competition rank and years of engaging in sports, the level of the exercise and strenuous and light physical exercise, with the latent variables of AIMS and PSICA.

The third goal was to determine the differences among the universities in different Balkan countries in the abovementioned main variables in research, while the fourth goal was focused on determining the differences among the students from different years of study in these variables.

Methods

Participants

The stratified sample included students from six (6) universities in ex-Yugoslavia. The participants in this study included 1498 (100%) female and male college sport students from the University of Mostar (100/6.68%), University of Ljubljana (320/21.36%), University of Split (133/8.88%), University of Zagreb (390/26.3%), University of Niš (330/22.03%) and University of Leposavić (225/15,2%) from whom we have collected questionnaire data. The students were attending a Physical Education (PE) course and the average age (M±SD) of the respondents was 20.35±1.76 (males) and 20.14±1.55 (females). According to the year of study, 853 (57%) students (610 male and 243 female) were from the first year of study, while 645 (43%) students (445 male and 200 female) were from the third year of study.

As seen in Table 1, a significant difference in the number of female and male students is found (Chi square=56.571; df=5; $p<0.01$). The biggest gender differences are observed in Leposavić (Kosovo), Niš (Serbia) and Mostar (Bosnia and Herzegovina), while the smallest difference is at the University of Ljubljana (Slovenia). Furthermore, there is a significant difference in the number of respondents by individual universities, which is caused by enrolment quotas, which depends on the budget which the state allocates for specific training of personnel in the sport. The universities are mainly financed from the state budget. Due to

TABLE 1 Structure of the sample of participants, by university and gender

	Mostar		Ljubljana		Split		Zagreb		Niš		Leposavić		Σ	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Males	79	79	194	61	85	64	250	64	261	79	186	83	1055	70,4
Females	21	21	126	39	48	36	140	36	69	21	39	17	443	29,6
All	100	100	320	100	133	100	390	100	330	100	225	100	1498	100,0

UDC 796.01-057.875(497)

the involvement of sports, most of the respondents are engaged in recreational sports (593 or 39.6%), then on the lower competition level (331 or 22.1%), the second division (221 or 14.8%), the first division (205 or 13.7%), while the smallest number are the members of the national team (148 or 9.9%).

Procedure

Data were collected during lessons and exercises for each group. At the time the questionnaires were distributed, these students had had basic lessons in PE. The authors of this paper declare that the research reported was undertaken in compliance with the Helsinki Declaration.

In this study, 1600 questionnaires were disseminated among students at the University of Mostar (100), University of Ljubljana (320), University of Split (133), University of Zagreb (390), University of Niš (330) and University of Leposavić (225). According to the instructions provided, 1498 students returned the questionnaires: 1055 male (70.4%) and 443 (29.6%) female students (more detailed information is presented in Table 1 and Table 2).

Instruments

Within this study, we have used the Athletic Identity Measurement Scale (AIMS), developed by Brewer, Van Raalte, and Linder (1993), which is made up of 10 items that are designed to assess the strength of athletic identity. Authors have defined athletic identity as the degree to which an individual identifies himself with an athletic role. All 10 items in the scales are answered on a 7-point Likert scale with response options ranging from 1-strongly disagree to 7-strongly agree. A total score was calculated for each respondent, which consisted of the sum of the responses to the 10 questionnaire items. Brewer et al. (1993) also demonstrated findings that AIMS scores are highly correlated with scores on the importance of the sports competence scale of the Perceived Importance Profile (PIP), ($r=0.83$, $p<0.0005$). They also found high internal consistency with an alpha coefficient of 0.93, as well as a test-retest reliability coefficient of 0.83 over a two-week period.

The second instrument used was the Psychological Skills Inventory for Chinese Athletes (PSICA). This inventory is for assessing the psychological skills of participants. We have used a modified 23-item scale which demonstrated good factorial validity. PSICA was developed based on a two-order structure of both Howe's (1993), and Hardy and Jones' (1994) conceptualizations. The revised 23-item PSICA was administered to 713 subjects ranging from college level to international level athletes. Cross-validation test revealed some problems with the model, and/or the inventory, but the convergent and discriminant validity test, and the test-retest reliability results indicated that the PSICA is a psychometrically suitable measuring instrument (Xiaochung, 1997).

Statistical analysis

The data were analysed with the IBM SPSS Statistics (24.0) software. The basic descriptive statistics were calculated (mean, standard deviation, frequency of answers). To determine the construct validity (separately for each gender) of the questionnaires (AIMS, PSICA), Principal Components Analysis with (or without, for AIMS) Varimax Rotation were used. The results in extracted principal components (factors) in questionnaires are expressed as simple linear combinations, and then used in further analysis. The reliability type internal consistency for all dimensions (components) of relevant factors about the engagement of women in sports was determined using Cronbach's alpha coefficients of internal consistency. Univariate ANOVAs, t-tests and two-factorial ANOVA were used to test the differences in the latent dimensions of the questionnaires, according to the gender, region and year of study. Pearson's correlation coefficient was used to determine the correlations between the relevant variables in the research (as a prerequisite, all the conditions for using the abovementioned statistical procedures are checked before application). Verification of the hypotheses was conducted at a 5 per cent level of statistical risk ($p\leq0.05$).

Results

The results showed that for the Athletic Identity Measuring Scale (AIMS) variables in a sample of male sport students from South-Eastern European countries, one principal component was obtained, which showed very high and very satisfactory reliability, explaining about 55% of the total variance (Table 2). All ten items very highly saturated the unique principal component, in a range from 0.446 to 0.855. In a sample of female students from South-Eastern European countries, one principal component was obtained, which showed very high and very satisfactory reliability, explaining about 50% of the total variance. All ten items very highly saturated the unique principal component, in a range from 0.495 to 0.826 (Table 2).

For the Psychological Skills Inventory for Chinese Athletes (PSICA) variables in a sample of male sport students from South-Eastern European countries, the results showed that four principal components were obtained, which showed moderate high to high and thus satisfactory reliability (ranging from 0.664 to 0.868), explaining from 9% to 18% of the overall variance. Eight items highly saturated the component named (on the basis of item contents) Motivation and Concentration; six items highly saturated the component named Anxiety Control; five items highly saturated the component named Visualization; four items highly saturated the component named Mental Preparation (Table 3a). The components with more items that are saturated show higher reliability and amount of variance explained.

TABLE 2 Construct validity and reliability of the athletic identity measuring scale (AIMS) for males and females

Males	Athletic identity	Communalities	Alpha if item deleted	Corrected item-total correlation
Sport is an important part of my life	.855	.731	.904	.769
To feel good, I have to play sports	.837	.700	.879	.765
Other people see me as an athlete	.831	.690	.880	.744
Many of my life goals are related to sports	.826	.682	.880	.744
I consider myself to be an athlete.	.813	.660	.882	.720
Most of the time I spend thinking about the sport	.769	.591	.882	.709
I would be very depressed if I could not continue to play sports because of the injury	.725	.526	.886	.656
Most of my friends are athletes	.642	.412	.892	.558
I think poorly about myself when I'm not good at sports	.535	.286	.900	.480
Sport is the only important thing in my life	.446	.199	.879	.398
Reliability	0.897	Kolmogorov-Smirnov Z	**2.031****	
Eigenvalue	5.478	Mean = 47.342		
Variance Explained (%)	54.784	Std. Dev.=11.180		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	**0.928**	**Bartlett's Test**	**5930.981****	df=45
Females	Athletic identity	Communalities	Alpha if item deleted	Corrected item-total correlation
Sport is an important part of my life	.826	.682	.744	.853
To feel good, I have to play sports	.818	.670	.858	.715
Other people see me as an athlete	.787	.620	.859	.675
Many of my life goals are related to sports	.780	.609	.859	.683
I consider myself to be an athlete.	.777	.604	.855	.713
Most of the time I spend thinking about the sport	.761	.580	.860	.650
I would be very depressed if I could not continue to play sports because of the injury	.642	.412	.867	.561
Most of my friends are athletes	.581	.338	.873	.491
I think poorly about myself when I'm not good at sports	.535	.286	.877	.472
Sport is the only important thing in my life	.495	.245	.878	.443
Reliability	0.876	Kolmogorov-Smirnov Z	**1.601***	
Eigenvalue	5.045	Mean = 49.928		
Variance Explained (%)	50.454	Std. Dev.=10.208		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	**0.892**	**Bartlett's Test**	**2153.994****	df=45

Legend: **significant at a level of p< .01; *significant at a level of p< .05
Note: only saturations above 0.40 are presented

In a sample of female sport students from South-Eastern European countries, four principal components were obtained, which showed moderate high to high and thus satisfactory reliability (ranging from 0.554 to 0.851), explaining from 8% to 17% of the overall variance. Eight items highly saturated the component named (on the base of item contents) Motivation and Concentration; seven items highly saturated the component named Visualization and Mental Preparation; five items highly saturated the component named Anxiety Control; three items highly saturated the component named Mental Preparation (Table 3b). The components with more items that are saturated generally show the higher reliability and amount of variance explained.

Overall, among male students, 33 statistically significant correlations between age, competition rank and years of engaging in sports, with the variables of questionnaires (as well as among the variables from the questionnaires) are found. Eighteen obtained significant correlations have negative direction, while the others are positive. The size of all correlations is very low, and it could be the result of the large sample size. Low-size of inter-correlations among the components revealed from the same instrument (PSICA) could be the consequence of the method of obtaining factor scores and methods of factorization. The highest size of significant (positive) correlations with Godin leisure time exercise are seen in the variables competition rank, years of engaging in sports, and athletic identity. In contrast, the highest size of significant (negative) correlations with Godin leisure time exercise is with Visualization and Motivation / concentration. The highest size of significant (positive) correlations with athletic identity is with the variables Competition rank and Years of

UDC 796.01-057.875(497)

TABLE 3A Construct validity and reliability of the Psychological Skills inventory for Chinese Athletes (PSICA) for males

Males	Motivation and concentration	Anxiety control	Visualization	Mental preparation	Communalities
I do not perceive the expectations of my coaches and relatives as pressure but as motivation.	**.706**				.540
Sports objectives motivate me to constantly improve my sports performance.	**.700**				.657
I perceive competition to be a test of my sporting abilities.	**.693**				.562
I can concentrate on the next moves in the game even if I made a mistake before.	**.688**				.568
I can concentrate on the key techniques and tactics without any problem.	**.657**				.520
With the help of incentive words, I can concentrate on some key moments of the competition.	**.519**				
I try to calm myself down when I start making errors in competition.	**.516**	.456			.533
Of course, I can imagine my athletic performance.	**.487**	.464			.515
I have certain methods to control my mental states before a competition.		**.681**			.490
I try to calm myself with words when I am tense.		**.656**			.475
When my confidence wavers, I say to myself that there will be no problem because I'm well trained	.426	**.553**			.553
During a very important competition, I try to reduce anxiety by treating it as everyday ordinary game.		**.547**			.400
I try to be mentally prepared.		**.540**			.504
I breathe deeply when I feel tense.		**.480**			
On the night before competition, I try to visualize the next day's competition.			**.761**		.625
A few days before the competition, I think about the competition course.			**.716**		.599
By visualizing the competition, I prepare myself for it.			**.686**		.706
I visualize images of the competition to boost my self-confidence.		.434	**.612**		.619
I visualize my techniques and tactics before the competition.		.489	**.552**		.636
When an opponent is better than me, I tell myself that I do not have to be afraid.				**.699**	.537
When I notice that I am losing concentration, I remind myself to concentrate on the key techniques and tactics.				**.654**	.548
I set realistic goals, and I try to achieve them.				**.608**	.522
Competitions are challenges for me.				**.572**	.633
Mean	17.344	14.777	11.815	7.306	
Std. Dev.	6.223	4.968	4.410	2.843	
Reliability	**0.868**	**0.785**	**0.826**	**0.664**	
Eigenvalue	4.124	3.586	2.928	2.004	
Variance Explained (%)	17.929	15.593	12.728	8.712	∑= **54.962%**
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	**0.945**	**Bartlett's Test**	**9863.279****	df=253	

Legend: **significant at a level of p< .01; *significant at a level of p< .05
Note: only saturations above 0.40 are presented

engaging in sports. The highest size of significant (negative) correlations athletic identity is with Visualization and Motivation / concentration (as compared with Godin's questionnaire, 1997) (Table 4).

In female students, 26 statistically significant correlations between age, competition rank, and years of engaging in sports, with the variables of questionnaires (as well as among the variables from the questionnaires) are found. Twelve obtained significant correlations have negative direction, while the others are positive. The size of all correlations is very low or low, which could be the result of a big sample size. The low size of inter-correlations among the components revealed from the same instrument (PSICA) could be the consequence of the method of obtaining factor scores and methods of factorization. The highest size of significant (positive) correlations with Godin leisure time exercise are with the variables Competition rank and Years of engaging in Sports, Athletic identity. The highest size of significant (negative) correlations with Godin leisure time exercise are with Visualization/ mental preparation and Motivation/concentration. The highest size of significant (positive) correlations with athletic identity are with the variables Competition rank and Years of engaging in sports. The highest size of significant (negative) correlations with athletic identity are with Visualization/ mental preparation and General mental preparation (as compared with Godin's questionnaire) (Table 4).

TABLE 3B Construct validity and reliability of the Psychological Skills inventory for Chinese Athletes (PSICA) for females

Females	Motivation and concentration	Anxiety control	Visualization	Mental preparation	Communalities
I breathe deeply when I feel tense.	**.749**				.587
With the help of incentive words, I can concentrate on some key moments of the competition.	**.712**				.618
I perceive competition to be a test of my sporting abilities.	**.643**				.528
Sports objectives motivate me to constantly improve my sports performance.	**.642**				.587
I try to calm myself down when I start making errors in competition	**.578**				.481
I am trying to calm myself with words when I am tense.	**.573**				.479
Of course, I can imagine my athletic performance.	**.485**				.478
I do not perceive expectations of my coaches and relatives as pressure but as motivation.	**.473**				.402
By visualizing the competition, I prepare myself for it.		**.733**			.660
On the night before competition, I am trying to visualize it.		**.726**			.646
I visualize images of a competition in order to boost my self-confidence.		**.707**			.604
A few days before a competition, I think about the competition course.		**.661**		.401	.624
I visualize my techniques and tactics before a competition.		**.657**			.569
I have certain methods to control my mental states before a competition.		**.568**			.497
I try to be mentally prepared.		**.568**			.510
I can concentrate on the next moves in the game even if I have made a mistake.			**.760**		.643
I can concentrate on the techniques and tactics without any problem.			**.681**		.565
When my confidence wavers, I tell myself that there will be no problem because I'm well trained.	.434		**.618**		.610
When the opponent is better than me, I tell myself that I do not have to be afraid.			**.476**	.467	.445
With a very important competition, I try to reduce anxiety by telling myself that it's an everyday ordinary game.			**.401**		.410
Competitions are the challenges for me.				**.655**	.536
I'm set realistic goals, and I try to achieve them.				**.612**	.497
When I notice that I am losing concentration, I remind myself to concentrate on key techniques and tactics.				**.510**	.450
Mean	16.411	16.187	11.474	5.178	
Std. Dev.	5.637	5.609	3.598	**1.771**	
Reliability	**0.843**	**0.851**	**0.734**	**0.554**	
Eigenvalue	3.993	3.807	2.673	1.953	
Variance Explained (%)	17.362	16.553	11.622	8.490	∑= **54.027%**
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	**0.922**	**Bartlett's Test**	**4061.333****	df=253	

Legend: **significant at a level of p< .01; *significant at a level of p< .05
Note: only saturations above 0.40 are presented

Table 5 displays the differences (tested by ANOVA) among the college sport students at the universities in different Balkan countries in the abovementioned main variables in research. The results revealed that statistically significant differences are found in the majority of the variables in the research. Differences among college sport students in four Balkan countries are not statistically significant only in Godin leisure time exercise (in females) and in two psychological skills: Visualization (in males) and Mental Preparation (in females). Among statistically significant differences in male college sport students, students from Ljubljana (Slovenia) have the highest means for the majority of the variables: Strenuous physical exercise, Light physical exercise, Level of the exercise, Sport identity, Anxiety control, and Time spent in exercising. Male students from Leposavić (Serbia) have the lowest means for Strenuous physical exercise, Light physical exercise, Level of the exercise, and Mental preparation. Among statistically significant differences, in female college sport students, students from the Ljubljana (Slovenia) have the highest means for the majority of the variables: Strenuous physical exercise, Level of the exercise, Sport identity, Anxiety Control, and Visualization. There are no clear trends for the lowest means in female students.

UDC 796.01-057.875(497)

TABLE 4 Correlations among the variables in the research for males and females

Males	Strenuous physical exercise	Light physical exercise	Godin leisure time exercise	males AIMS factor	Motivation / concentration	Anxiety Control	Visualization	Mental preparation
Age	-.103**	.070*	-.141**	.054	.036	-.062*	.076*	.014
Competition rank	.337**	.002	.356**	.226**	-.132**	.032	-.167**	.012
Years of engaging in sports	.313**	.030	.300**	.218**	-.149**	.016	-.121**	-.030
Strenuous physical exercise	1	.130**	.260**	.087**	-.095**	.090**	-.072*	.003
Light physical exercise		1	.140**	.016	-.001	-.079*	-.048	.005
Godin leisure time exercise			1	.208**	-.130**	-.084**	-.150**	-.065*
Males AIMS factor				1	-.152**	.029	-.213**	-.029
Motivation / Concentration					1	-.099**	.005	.062*
Anxiety Control						1	.045	.068*
Visualization							1	-.031
Mental preparation								1

Females	Strenuous physical exercise	Light physical exercise	Godin leisure time exercise	females AIMS factor	Motivation / concentration	Anxiety Control	Visualization / mental preparation	General mental preparation
Age	-.085	-.023	-.127**	.051	.126**	-.012	-.032	.040
Competition rank	.398**	.041	.449**	.326**	-.080	-.014	-.116*	-.193**
Years of engaging in sports	.361**	.023	.399**	.326**	-.064	.014	-.093*	-.185**
Strenuous physical exerc.	1	.114*	.290**	.184**	-.049	.111*	-.103*	.003
Light physical exercise		1	.051	.084	-.042	.009	-.150**	-.003
Godin leisure time exercise			1	.281**	-.122**	.014	-.155**	-.101*
Females AIMS factor				1	-.108*	-.014	-.193**	-.191**
Motivation / concentration					1	-.076	.015	.160**
Visualization/mental prepar.						.029	.029	.016
Anxiety Control							1	.039
General mental preparation								1

Legend: ** Correlation is significant at the .01 level (2-tailed); * Correlation is significant at the .05 level (2-tailed).

Table 6 displays the differences (tested by t-test for independent samples) between college sport students at the two years of study (first and third) at universities in different Balkan countries in the main variables in this research. The results revealed that statistically significant differences are found for five (from a total of nine) variables in research for male sport students, while only two differences are statistically significant for female sport students. Female students in the first year of study are more engaged in Strenuous physical exercise and have higher scores in Godin leisure time exercise (as compared with female students from the third year of study). In contrast, male students in the first year of study are more engaged in Strenuous physical exercise and have higher scores in Godin leisure time exercise (the same as females) but also showed lower scores in Light physical exercising, Sport identity and Motivation and Concentration (than male students form the third year of study).

Statistically significant interaction is also found among the variables year of study and gender (using two-factorial ANOVA), both for males (Pillai's Trace= 0.171; F=4.082; p<0.001) and females (Pillai's Trace= 0.210; F=2.350; p<0.001). Among females, interactions are reflected in statistically significant (p<0.05) differences in the variables Strenuous physical exercise, Light physical exercise, Level of exercise, and Godin's leisure time exercise index. Among males, interactions are reflected in statistically significant (p<0.05) differences in the variables Godin's leisure time exercise index, Motivation / Concentration, and Athletic identity. Among females, interactions are reflected in statistically significant (p<0.05) differences in all variables for the third year of study, while for the first year, the differences were only reflected for Strenuous physical exercise and Light physical exercise. Among males, interactions are reflected in statistically significant (p<0.05) differences in all variables for the third year of study, while for the first year, the differences were only reflected for Godin's leisure time exercise index and Athletic identity.

Discussion

The results revealed that both psychological measuring instruments (the Athletic Identity Measurement Scale and the Psychological Skills Inventory for Chinese Athletes), applied on the samples of male and female college sport students in four Balkan countries, showed very satisfactory construct validity and reliability.

TABLE 5 Differences among the universities in different countries in main variables of the research

		Males			Females		
		Mean±Std.Dev.	F df (5, 1049)	Significant Differences (Bonferonni)	Mean±Std.Dev.	F df (5, 437)	Significant Differences (Bonferonni)
Strenuous physical exercise in minutes	Mostar	53.99±29.768	**18.461****	M-Lj, M-N, Lj-Z, Lj-S, Lj-L, S-L, Z-L, N-L	52.38±24.475	**5.957****	M-Lj, Lj-L, N-L, Lj-Z
	Ljubljana	**83.12**±28.837			**72.82**±36.086		
	Split	65.65±32.921			56.46±34.099		
	Zagreb	62.92±33.871			54.32±38.990		
	Niš	67.01±36.819			69.42±37.047		
	Leposavić	**52.72**±34.142			**46.54**±33.895		
Light physical exercise in minutes	Mostar	33.92±27.766	**5.791****	M-L, Lj-L, S-L, Z-L, N-L	41.19±13.314	**5.020****	S-Z, Lj-Z, S-Lj
	Ljubljana	**36.34**±28.202			43.10±21.372		
	Split	33.65±28.861			**51.46**±33.117		
	Zagreb	32.59±29.174			**32.32**±26.865		
	Niš	35.28±27.050			40.00±26.624		
	Leposavić	**23.06**±23.331			34.74±27.672		
Level of the exercise	Mostar	1.51±.904	**7.230****	M-Lj, M-S, N-Lj, N-S, Z-Lj, Z-S, L-Lj	1.29±.644	**3.151****	Lj-Z
	Ljubljana	**1.13**±.442			**1.21**±.511		
	Split	1.29±.704			1.48±.772		
	Zagreb	**1.53**±.923			**1.56**±.969		
	Niš	1.47±.787			1.42±.715		
	Leposavić	1.42±.776			1.46±.756		
AIMS	Mostar	-0.32±0.850	**32.502****	Lj-N, Lj-M, Lj-S, Lj-L, Lj-Z, Z-N, Z-M, N-L, M-L	0.00±1.136	**6.500****	Lj-N, M-N, Z-N, S-N, L-N, Lj-L
	Ljubljana	**0.57**±0.721			**0.29**±0.834		
	Split	-0.01±0.874			-0.03±0.985		
	Zagreb	0.17±0.953			0.05±1.020		
	Niš	**-0.49**±1.088			**-0.52**±1.007		
	Leposavić	0.00±0.923			-0.14±1.019		
Motivation and concentration	Mostar	-0.11±0.839	**12.085****	L-Lj, L-M, L-N, L-S, L-Z, Lj-Z	0.01±0.803	**11.342****	Lj-L, S-L, N-L, Z-L, M-L
	Ljubljana	**-0.28**±0.725			**-0.24**±0.785		
	Split	-0.04±0.632			-0.05±0.743		
	Zagreb	-0.02±0.840			0.05±0.870		
	Niš	-0.06±0.908			-0.19±0.837		
	Leposavić	**0.46**±1.501			**1.02**±1.795		
Anxiety control	Mostar	-0.05±1.001	**14.802****	Lj-N, Lj-S, Lj-M, Lj-L, Lj-Z	-0.04±0.770	**8.707****	Lj-N, Lj-L, N-Z, N-S, N-M, Lj-M, Lj-S, Lj-Z
	Ljubljana	**0.42**±0.928			**0.38**±0.888		
	Split	-0.14±0.901			-0.04±0.846		
	Zagreb	0.08±0.923			0.00±1.011		
	Niš	**-0.35**±0.953			**-0.54**±0.915		
	Leposavić	0.03±1.099			-0.21±1.245		
Visualization	Mostar	0.08±0.991	1.052	-	**-0.37**±0.789	**3.698****	M-Lj, N-Lj, S-Lj, M-L, M-Z
	Ljubljana	0.01±1.071			**0.27**±1.069		
	Split	-0.19±1.053			-0.16±0.932		
	Zagreb	-0.05±0.979			-0.01±1.103		
	Niš	0.06±1.034			-0.26±0.726		
	Leposavić	0.02±0.872			0.01±0.778		
Mental preparation	Mostar	-0.22±0.898	**10.471****	L-Z, L-Lj, L-N, L-S, M-Z, M-N, S-Z	-0.01±1.033	1.961	-
	Ljubljana	0.12±0.819			-0.02±0.830		
	Split	-0.06±0.881			-0.12±0.797		
	Zagreb	**0.20**±0.854			0.19±1.023		
	Niš	0.10±1.109			-0.11±0.987		
	Leposavić	**-0.41**±1.150			-0.28±1.480		
Godin leisure time exercise	Mostar	51.91±28.498	**7.150****	Lj-L, Lj-Z, Lj-S, N-L, N-Z	42.00±11.925	0.889	-
	Ljubljana	**57.28**±19.586			50.60±20.228		
	Split	50.19±25.821			48.94±20.140		
	Zagreb	47.93±19.459			47.91±21.833		
	Niš	53.68±17.987			50.83±18.882		
	Leposavić	**47.19**±17.069			48.31±16.050		

UDC 796.01-057.875(497)

TABLE 6 Differences among the students on different year of study in main variables of the research

		Females			Males		
	year of study	Mean	Std. Deviation	t-test (df=441)	Mean	Std. Deviation	t-test (df=441)
Strenuous physical exercise in minutes	1	65.35	36.994	**2.474***	69.02	35.035	**3.980****
	3	56.58	37.338		60.44	33.936	
Light physical exercise in minutes	1	39.77	25.537	0.427	30.93	27.151	**-2.096***
	3	38.70	27.318		34.54	28.311	
level of the exercise	1	1.37	.723	-1.130	1.37	.742	-1.728
	3	1.46	.832		1.45	.839	
AIMS factor	1	-0.04	1.003	-0.962	-.12	1.042	**-4.453****
	3	0.05	0.996		.16	.917	
Motivation and concentration	1	-0.07	1.001	-1.629	-0.09	0.969	**-3.478****
	3	0.09	0.995		0.12	1.029	
Visualization	1	0.03	1.024	0.734	-0.05	1.000	-1.945
	3	-0.04	0.971		0.07	0.998	
Anxiety control	1	0.03	1.032	0.593	0.02	0.990	0.871
	3	-0.03	0.961		-0.03	1.014	
Mental preparation	1	0.00	0.969	-0.065	.03	1.037	0.978
	3	0.00	1.039		-.04	.946	
Godin leisure time exercise	1	52.75	19.249	**4.473****	54.80	20.537	**6.400****
	3	44.43	19.778		46.79	19.386	

Reliability is especially high for males and for the instrument AIMS, while for PSICA it is mainly moderate to high, despite the fact that it is in general lower than for AIMS, in males and females. It seems that (with certain limitations) both concepts do not need gender-differentiated conceptualizations. Specifically, factor structures are relatively similar and not so different that they need separate factor solutions. Previous studies (e.g., Brewer & Cornelius, 2001; Hale, James & Stambulova, 1999) have examined the psychometric properties of the AIMS, including internal consistency, validity, and factor structure. These studies generally have shown AIMS to be a reliable and valid measurement in English-speaking cultures (when used as a multi-dimensional assessment tool) (Li, 2006). In addition to English-speaking cultures, AIMS appeared as an acceptable psychometric instrument for Russian athletes (Hale et al., 1999) and Hong Kong Chinese culture (Li, 2006), while AIMS-plus (which highly correlates with AIMS) seems to be a good measure for athletic identity in the Portuguese population (Cabrita, Rosado, Oliveira Leite & Malico Sousa, 2014). Therefore, the results of our study are in line with the thesis that athletic identity may be defined as being the degree of importance, strength, and exclusivity that is attached to the athlete's role which is maintained by him/herself and his/her context (Cieslak, 2004).

In this research, we have used unidimensional operationalization of AIMS, similar as in one of the conceptualizations in Hong Kong Chinese culture (Li, 2006), which appeared to be the most acceptable. The correlations between the students' Competition rank and Years of engaging in sports, Level of exercise, as well as Strenuous and Light physical exercise, with the dimensions of Athletic identity and Psychological skills are mainly low, and relatively similarly positively directed (somewhat more in females) and negatively (somewhat more in males). In males, relatively more positive correlations between the abovementioned variables are found. In both males and females, the highest positive correlations with Godin Leisure time exercise are with Competition rank, Years of engaging in sports, and Athletic identity, while the highest negative correlations are with Visualization/ Mental Preparation and Motivation/ concentration. Positive correlations of Competition rank, Years of engaging in sports, and Athletic identity with general leisure time exercise are easily explainable, with deeper involvement in sports for students who are more actively engaged in sports.

For the negative correlations obtained, which are mainly found with the variables of psychological skills, possible explanations could lead to two features of our study. First, our participants are mainly full-time students, who are primarily and currently not involved in top-level sport (therefore, the strong positive correlations of psychological skills with the variables of Competition rank, Years of engaging in sports, Athletic identity, and Physical exercise could not be expected). This explanation is supported by one US study (Whipple, 2009). The relationships between the level of athletic identity, identity foreclosure, and career maturity among the sample of NCAA Division III student-athletes were much weaker than in the sample of NCAA Division I student-athletes. These data suggest that NCAA Division III student-athletes may negotiate their identity hierarchies differently than student-athletes competing at the NCAA Division I level do (Whipple, 2009).

Second, all negative correlations are very low (because of the relatively high number of participants) and the meaning of "statistically significant correlations" is, in this case, overestimated. Differences in the correlations

in males and females, especially the trend that more positive significant correlations are found in males, could be explained by the fact that, despite the probable lower sport achievements in all full-time students, in most sports, male students have stronger competition concurrency. This concurrency could lead to the higher importance of sport psychological skills, as well as their relationship with athletic identity and other relevant variables, such as age, competition rank, years of engaging in sports, and intensity (level) of regular physical exercise. The results are in line with Pauline (2013), who revealed that males are engaged in more minutes per session of vigorous and moderate intensity physical activity than females are. However, the main difference is in different motivations for exercising: women were more motivated by weight management, appearance, nimbleness, positive health, and stress management, and men were motivated by performance and ego-oriented factors, such as challenge, strength, and endurance, competition, affiliation, having higher levels of coping and scheduling self-efficacy for physical activity than females were (Pauline, 2013).

Statistically significant differences among the college sport students on the universities in different Balkan countries are mainly reflected in the highest means for male and female students from Ljubljana (Slovenia), with the lowest means in several variables for male students from Leposavić (Serbia). The biggest differences in all variables between students from Ljubljana and Leposavić could be explained by the traditional values of sport in these two countries: Slovenia valued sport as a healthy lifestyle, especially through the school system of the first years of primary school. Furthermore, in some of the sports (skiing, sports dancing, basketball, handball, etc.), Slovenian athletes achieved outstanding results in international competitions. Particularly significant large differences could be observed in Strenuous physical exercise (both for males and females) and in Light physical exercise (in males) between the students from Ljubljana and Leposavić, and slightly lower among students (both male and female) from other faculties.

Unlike the Faculty of Sport in Leposavić (which is located in Kosovo), Ljubljana, the capital of Slovenia has a long sporting tradition and the Faculty of Sport, which existed from the time of the former Yugoslavia. On the contrary, the Faculty in Leposavić was established after the breakup of Yugoslavia. Due to the small town of Leposavić in Kosovo, where the majority of inhabitants are Serbian (where Faculty of Sport is part of the University of Pristina), it could be assumed that better athletes prefer to study in Belgrade, Niš, and Novi Sad, which have a longer tradition and more sports clubs, in which students athletes can find better conditions for achieving top results. Additionally, in most countries, the sports clubs with the best working conditions are located in capital cities, with a consequence of attracting the best athletes, who afterward continue to live and study in their new city. According to the results of the study in Leposavić, those students who remain to study do not have sport as a lifestyle. They are studying at the Faculty of Sports for their passive interest for sport or because of a desire to work in education, which is a relatively secure job in the former states of Yugoslavia. Maslow (1970) compared needs for being a member of something, love and other social needs, which includes giving and accepting, and which are more dominant in the Western society. Athletes are content to be part of a team where they can fulfill such needs; they are content to be noticed, to have a certain status.

According to the level of physical exercise, the highest level is found in Ljubljana and the lowest in Zagreb. Explanation for this discrepancy could be the fact that in Zagreb, there are two modes of study: regular (full-time) and irregular (part-time). On the regular study are mainly included the students that are not top athletes, because regular studies are organized with mandatory lectures and exercises, which require the students' full-day engagement at the university. Top athletes who want to pursue a career as a coach, enroll in part-time study that allows the students to be engaged in the competitive sport even during the study. In part-time study, in the first year of study student-athletes are focused on the modules of sports, fitness, physical conditioning or recreation, with the possibility of completing their studies after three years (baccalareus), while the regular program lasts for five years and primarily educates students to work in education. We should bear in mind that in this research are included only the students from full-time study (and who are mainly not top-level athletes). Cultural influences of all four countries include beliefs, customs, values and generational status. Bosnia and Hercegovina, Croatia, Slovenia, and Serbia have developed under the impact of many different cultures (Greek, Roman, Celtic, Illyrian, Austrian, Hungarian, Byzantine, Islamic) whose influences have left their unique imprint on the history (Sindik et al., 2013). Related to the abovementioned fact, it can be assumed that, with respect to cultural heritage, sports involvement, athletic identity and physical exercise habits of students of the faculties of sport in the four states in former Yugoslavia are different, as is evident from the results (Table 5).

Male and female students who are in the first year of study are more engaged in strenuous physical exercise and have higher scores in Godin leisure time exercise (as compared with students from the third year of study). In male students, students from the third year of study have higher means in light physical exercise, athletic identity and motivation/concentration (Table 6). One of the most likely explanations should be decreasing the intensity of physical exercise in young people, even in sport students. The insufficient time due to study or additional work to earn some money for their living expenses, together with lack of motivation for physical exercise have already been confirmed to be the main reasons for less often participating in sports and physical exercise in sport students (Kolar, Cerar, Piletič, Svetlik & Kugovnik, 2009; Kondrič et al., 2013; Turkmen, 2013).

The main strength of this study is that it includes the wide range of ex-Yugoslav countries and universities with sport students, examining their level of physical exercise and very rarely studied concepts of athletic

identity and sport psychological skills (in this environment). One purpose of the present study was to determine whether the PSICA subscales demonstrated acceptable reliability and basic construct validity when administered to a sample of male and female students, and this purpose showed initially satisfactory results. Moreover, insights in correlations between main and relevant variables in the research, together with findings regarding the differences according to the year of study, between the universities, provide useful information for future researchers.

There are a few limitations to this study. One is almost the always present shortcoming which appears in psychological studies based on self-administered questionnaires: it is questionable how much the responses for each individual are biased by social desirability or the possibility of realistically estimating themselves. Also, the study has limited geographical coverage, since the study was conducted in a limited number of faculties in ex-Yugoslavia.

In future studies, there is still a need for further investigation of the psychometric properties of PSICA and AIMS across a group of male and female sport students, testing different conceptualizations of whether the athletic identity and psychological skills, applying different approaches (Sindik et al., 2013). Larger and more representative (simple randomized or pure stratified) sample(s) is/are always desirable.

Despite these shortcomings, the results provide information about the differences in relevant kinesiological and psychological sport-related variables in ex-Yugoslav countries and particular universities, stratified by gender. These insights could help in finding country-(or university-)differentiated programs for achieving higher motivation of sport college students for physical exercise.

Conclusions

Both psychological measuring instruments used in this study (Athletic Identity Measurement Scale and Psychological Skills Inventory for Chinese Athletes), applied on the samples of male and female college sport students in four Balkan countries, showed very satisfactory psychometric properties. Reliability is particularly high for males for AIMS, while the reliabilities for PSICA are mainly moderate to high and lower than for AIMS, both in males and females. In the future, it seems that (with certain limitations) both concepts do not need gender-differentiated conceptualizations.

The correlations between the variables in research, the students' competition rank, years of engaging in sports, level of exercise, strenuous and light physical exercise, with the variables of sport identity, and psychological skills are mainly low. Among males and females, the highest positive correlations with Godin leisure time exercise are the variables Competition rank, Years of engaging in sports, and Athletic identity. The highest negative correlations with Godin leisure time exercise are found with two composite psychological skills: Visualization/ Mental Preparation and Motivation/ Concentration. Statistically significant differences among the college sport students on the universities in different Balkan countries could be summarized in terms of the highest means obtained for male and female students from Ljubljana (Slovenia), with the lowest means in several variables for male students from Leposavić (Serbia). In females, the clear trend of the lowest means in particular countries is not found. In male and female college sport students, students from the first year of study are more engaged in strenuous physical exercise and have higher scores in Godin leisure time exercise (as compared with students from the third year of study). In male students, students from the third year of study have higher means in Light physical exercise, Sport identity, and Motivation/Concentration.

REFERENCES

Afsanepurak, S.A., Seyed Hossini, R.N., Seyfari, M.K., & Fathi, H. (2012). Analysis of motivation for participation in sport for all. *International Research Journal of Applied and Basic Sciences, 3*(4), 790-795.

Amsterdam declaration on sport (1997). Treaty of Amsterdam amending the treaty on European union, the treaties establishing The European communities and certain related acts. Availabe at http://www.europarl.europa.eu/topics/treaty/pdf /amst-en.pdf.

Andreff, W. (2006). "Sport and financing". In W. Andreff and S. Szymanski, (Eds). *Handbook on the Economics of Sport*. (pp. 271-281). Cheltenham: Edward Elgar.

Bobek, S.S., & Caldwell, L.L. (2007). Factors Related to Physically Active Leisure among College Students. *Leisure Sciences: An Interdisciplinary Journal, 28*(1), 73-89.

Brewer, B.W., & Cornelius, A.E. (2001). Norms and factorial invariance of the Athletic Identity Measurement Scale (AIMS). *Academic Athletic Journal, 16*, 103-113.

Browder, D.M. (2001). *Curriculum and Assesment for Students with Moderate and Severe Disabilities*. New York: Guilford Press.

Brewer, W.B., Van Raalte, J.L., & Linder, D.E. (1993). Athletic identity: Hercules' muscle of Achilles' heel? *International Journal of Sport Psychology, 24*, 237-254.

Buckworth, J., & Nigg, C. (2004). Physical activity, exercise, and sedentary behavior in college students. *Journal of American College Health, 53*(1), 28-34.

Cabrita, T.M., Rosado, A.B., Oliveira Leite, T., & Malico Sousa, P. (2014). Adaptation of the athletic identity measurement scale (AIMS-Plus) for the portuguese population. *Psicologia: Reflexão e Crítica*, *27*(1), 29-37.

Carney, C.E., Edinger, J.D., Meyer, B., Lindman, L., & Istre, T. (2006). Daily activities and sleep quality in college students. *Chronobiology International, 23*(3), 623-637. Doi: 10.1080/07420520600650695

Caspersen, C.J., Pereira, M.A., & Curran, K.M. (2000). Changes in physical activity patterns in the United States, by sex and cross-sectional age. *Med Sci Sports Exerc, 32*, 1601-1609.

Cieslak, T. (2004). *Describing and measuring the athletic identity construct: Scale development and validation* (Unpublished doctoral dissertation). Ohio State University, Columbus, OH.

Ebben, W., & Brudzynski, L. (2008). Motivations and barriers to exercise among college students. *Journal of Exercise Physiologyonline, 11*:5

Ebben, W.P., & Gagnon, J. (2012). The Relationship Between Mental Skills, Experience, and Stock Car Racing Performance. *Journal of Exercise Physiology, 15*(3), 10-18.

Egli, T., Bland, H.W., Melton, B.F., & Czech, D.R. (2011) Influence of age, sex and race on college students' exercise motivation of physical activity. *Journal of American College Health, 59*(5), 399-406.

Elferink-Gemser, M.T., Visscher, C., & Lemmink, K.A.P.M. (2008). Differences in psychological skills between elite and sub-elite youth athletes. *Journal of Physical Education and Sport Sciences, 4*, 95-105.

Fang, J. (2007) Research on motivation, attribution, self-efficacy and sport learning effects. *Journal of Beijing Sport University, 30*, 1691-1692.

Fountaine, J.C., Liguori, G.A., Mozumdar, A., & Schuna, J.M.Jr. (2011). Physical activity and screen time sedentary behaviors in college students. *International Journal of Exercise Science, 4*(2), 102-112.

Furjan-Mandić, G., Kondrič, M., Tušak, M., Rausavljević, N., & Kondrič, L. (2010). Sport students' motivation for participating in table tennis at the Faculty of Kinesiology in Zagreb. *International journal of table tennis sciences, 6*, 52-55.

Gadžić, A., & Vučković, I. (2009). Participation in sports and sociometric status of adolescents. *Biomedical Human Kinetics, 1*, 83 – 85.

Gaston-Gayles, J.L. (2004). Examining academic and athletic motivation among student athletes at a division I university. *Journal of College Student Development, 45*(1), 75-83.

Godin, G., & Shephard, R.J. (1997). Godin Leisure-Time Exercise Questionnaire. *Medicine and Science in Sports and Exercise, 29*(Supplement), S36-S38.

Good, A.J., Brewer, B.W., Petitpas, A.J., Van Raalte, J.L., & Mahar, M.T. (1993). Identity foreclosure, athletic identity, and college participation. *The Academic Athletic Journal, Spring, 1*, 12.

Goudas, M., & Hassandra, M. (2006) Greek students' motives for participation in physical education. *International Journal of Physical Education, 43*, 85-89.

Hale, B. D., James, B., & Stambulova, N. (1999). Determining the dimensionality of athletic identity: A Herculean cross-cultural undertaking. *International Journal of Sport Psychology, 30*, 83-100.

Hardy, L., & Jones, G. (1994). Current issues and future directions for performance- related research in sport psychology. *Journal of Sports Science, 12*, 61-92.

Haskell, W.L., Lee, I.M., Pate, R.R., Powell, K.E., Blair, S.N., Franklin, B.A., Macera, C.A., Heath, G.W., Thompson, P.D., & Bauman, A. (2007). Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Med Sci Sports Exerc, 39*(8), 1423-34.

Howe, B. (1993). Psychological skills and coaching. *Sport Science Review, 2*, 30-47.

Jaakkola, T., & Liukkonen, J. (2006). Changes in students' self-determined motivation and goal orientation as a result of motivational climate intervention within high school physical education classes. *International Journal of Sport & Exercise Psychology, 4*(3), 302-324.

Judge, L., Bellar, D., Lee, D., Petersen, J., Wanless, E., Surber, K., Ferkel, R., & Simon, L. (2012). An Exploratory Study of Physical Activity Patterns of College Students at a Midwest State University in the United States. *The Sport Journal,* Volume 15, 1116.

Jurak, G., Andreff, W., Popović, S., Jakšić, D., & Bednarik, J. (2014). The impact of the global economic crisis on the finances of non-governmental sport organizations in Slovenia remains to be seen. *Motriz, 20*(2), 131-142. doi: dx.doi.org/ 10.1590/S1980-65742014000200002.

Keating, X.D., Guan, J., Pinero, J.C., & Bridges, D.M. (2005). A meta-analysis of college students' physical activity behaviors. *Journal of American College Health, 54*(2), 116-125.

Kilpatrick, M., Hebert, E., & Bartholomew, J. (2005). College Student's Motivation for Physical Activity: Differentiating Men's and Women's Motives for Sport Participation and Exercise. *Journal of American College Health, 54*(2), 87-94.

Kolar, E., Cerar, K., Piletič, S., Svetlik, I., & Kugovnik O. (2009) Analysis of some aspects of the sports activity of University of Ljubljana students. *Šport*, *57*(3-4), 20-27.

Kondrič, M., Furjan-Mandić, G., & Munivrana, G. (2011). Sport students' motivation in table tennis course at the Faculty of sport in Ljubljana. *Gymnasium, 12*(1), 154-159.

Kondrič, M., Sindik, J., Furjan-Mandić, G., & Schiefler, B. (2013). Participation Motivation and student's physical activity among sport students in three countries. *Journal of Sports Science and Medicine, 12*(1), 10-18.

Lally, P.S., & Kerr, G.A. (2005). The career planning, athletic identity, and student role identity of intercollegiate student athletes. *Research Quarterly for Exercise and Sport, 76,* 275-285.

Li, H.Y. (2006). *Validation of the Athletic Identity Measurement Scale With a Hong Kong Sample*. PhD thesis, Victoria University. Available at http://vuir.vu.edu.au/519/1/ 02whole.pdf

Lutz, R S., Karoly, P., & Okun, M.A. (2008). The why and the how of goal pursuit: Self-determination, goal process cognition, and participation in physical exercise. *Psychology of Sport & Exercise, 9*, 559-575.
Mahoney, M.J., Gabriel, T.J., & Perkins, T.S. (1987). Psychological skills and exceptional athletic performance. *Sport Psychologist, 1*, 181-199.
Mahoney, M.J. (1989). Psychological Predictors of elite and non-elite performance in Olympic weightlifting. *International Journal of Sports Psychology, 20*, 1-12.
Majerič, M., & Markelj, N. (2009). Analiza nekaterih dejavnikov ukvarjanja s športom pri študentih = Analysis of some factors of students' engagement in sport. *Šport*, *57*(3/4), 14-17.
Markland, D., & Ingledew, D.K. (2007). The relationships between body mass and body image and relative autonomy for exercise among adolescent males and females. *Psychol Sport Exerc, 8*, 836-853.
Maslow, A.H. (1970). *Motivation and personality (2nd ed.).* New York, Harper & Row.
Melendez, M. C. (2006). The influence of athletic participation on the college adjustment Athlete Identity 16 of freshmen and sophomore student athletes. *Journal of College Student Retention: Research, Theory and Practice, 8*(1), 39-55.
Mihajlovic, M., Komnenic, N., Kastratovic, E., & Cilerdzic, V. (2010). Volunteers in Sport Organizations. Choregia*, 6*(2), 5-18
Miller, P.S., & Kerr, G. (2002). The athletic, academic and social experiences of intercollegiate student-athletes. *Journal of Sport Behavior, 25,* 346-367.
Miller, P.S. & Kerr, G.A. (2003). The role experimentation of intercollegiate student athletes. *The Sport Psychologist, 17*, 196-219.
Miller, K., Staten, R.R., Rayens, M.K., & Nolan, M. (2005). Levels and Characteristics of Physical Activity Among a College Student Cohort. *American Journal of Health Education, 36*(4), 215-220.
Moreno, J. A., Gonzales-Cutre, D., Martin-Albo, J., & Cervello, E. (2010). Motivation and performance in physical education: An experimental test. *Journal of Sports Science and Medicine, 99*, 79-85.
Moreno, J. A., Lopez de San Roman Blanco, M., Martinez Galindo, C., Alonso Villodre, N., & Gonzales-Cutre Coll, D. (2008). Effects of the gender, the age and the practice frequency in the motivation and the enjoyment of the physical exercise. *Fitness & Performance, 6*(3), 140-146.
Morgan, W. P. (1994). Physical activity, fitness and depression. In C. Bouchard, R. J. Shephard, and T. Stephens (Eds.), *Physical Activity, Fitness, and Health: International Proceedings and Consensus Statement* (pp. 851–867). Champaign, IL: Human Kinetics Publishers.
Nice declaration on sport, 2000. Available at http://oxfordindex.oup.com/view/10.1093/oi/authority.20110803100233345
Pauline, J.S. (2013). Physical Activity Behaviors, Motivation, and Self-Efficacy Among College Students. *College Student Journal*, *47*(1), 64-74.
Proios, M., Proios, M.C., Mavrovouniotis, F., & Theofanis, S. (2012). An exploratory study of athletic identity in university physical education students. *Graduate Journal of Sport, Exercise & Physical Education Research, 1,* 98-107.
Racette, S.B., Deusinger, S.S., Strube, M.J., Highstein, G.R., & Deusinger, R.H. (2008). Changes in Weight and Health Behaviors from Freshman through Senior Year of College. *J Nutr Educ Behav, 40, 39-42.*
Shashank, P.B., Richa Y., & Prakash, B.B. (2013). A comparative study of stress among students of medicine, engeneering and nursing. *Indian Journal of Psychological Medicine, 33*(2), 145-148.
Sindik, J. (2014). The Comparison of the Psychological Skills in Sport Trainers and recreational table tennis players. *Physical Culture, 68*(2), 150-158.
Sindik, J., Furjan-Mandić, G., Schiefler, B., & Kondrič, M. (2013). Differences in the structure of motivation for participation in sport activities among sport students in three countries. *Kinesiologia Slovenica, 19*(1), 14-31.
Sindik, J., & Vojnović, N. (2012). Sex differences in the attitudes of students of physical education related to leisure and recreational sports activities. *Sport Science*, *5*(2),36-39.
Spieler, M.J. (2006). Predicting Starting Status: Factors Contributing to the Success of Collegiate Football Players. Electronic Theses & Dissertations. Georgia: Georgia Southern University.
Strel, J., & Sila, B. (2010). Športne dejavnosti slovenske mladine med 15. in 18. letom starosti [Sport activity of Slovenian adolescents aged between 15 and 18]. *Šport, 58*, 124-129.
Stryker, S., & Burke, P.J. (2000). The past, present, and future of an identity theory. *Social Psychology Quarterly, 63*(4), 284-297.
Škorić, S., Bartoluci, M., & Čustonja, Z. (2012). Public financing in Croatian sport. *Financial theory and practice, 36*(2), 179-197.
Taras, H. (2005). Physical activity and student performance at school. *Journal of School Health, 75*(6), 214-218.
Turkmen, M. (2013). Investigation of the relationship between academic and sport motivation orientations. *Middle-East Journal of Scientific Research, 16*(7), 1008-1014.
Van Dyck, D., De Bourdeaudhuij, I., Deliens, T., & Deforche, B. (2015). Can changes in psychosocial factors and residency explain the decrease in physical activity during the transition from high school to college or university? *Int J Behav Med, 22*(2), 178-86. doi: 10.1007/s12529-014-9424-4.
Van Heerden, C.H. (2014). The relationships between motivation type and sport participation among students in a South African context. *Journal of Physical Education and Sport Management*, *5*(6), 66-71.
Verloigne, M., De Bourdeaudhuij, I., Tanghe, A., D'Hondt, E., Theuwis, L., Vansteenkiste, M., & Deforche,

B. (2011). Self-determined motivation towards physical activity in adolescents treated for obesity: an observational study. *International Journal of Behavioral Nutrition and Physical Activity, 88*(97), 2-11.

Visek, A.J., Hurst, J.R., Maxwell, J.P., & Watson II, J.C. (2008). A Cross-Cultural Psychometric Evaluation of the Athletic Identity Measurement Scale. *Journal of Applied Sport Psychology, 20*(4), 473-480. doi: 10.1080/10413200802415048

Wallace, L.S., & Buckworth, J. (2001). Application of the transtheoretical model to exercise behaviour among non-traditional college students. *American Journal of Health,32*, 39-47.

Wallace, L.S., Buckworth, J., Kirby, T.E., & Shermann, W.M. (2000). Characteristics of exercise behaviour among college students: application of social cognitive theory to predicting stage of change. *Preventive Medicine, 31*, 494-505.

Whipple, K.R. (2009). *Athletic identity, identity foreclosure, and career maturity: An investigation of intercollegiate athletes*. Master Thesis. Ames, Iowa: Iowa State University.

White paper on sport (2007). Available on http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52007DC0391

Woodruff, A. L., & Schallert, D. L. (2008). Studying to play, playing to study: Nine college student-athletes' motivational sense of self. *Contemporary Educational Psychology, 33*(1), 34-57.

Yopyk, D. J. A., & Prentice, D. A. (2005). Am I an athlete or a student? Identity salience and stereotype threat in student-athletes. *Basic and Applied Social Psychology, 27*(4), 329-336.

Xiaochung, Y. (1997). *Development of the Psychological Skills inventory for Chinese Athletes*. (Master thesis). Vancouver: The University of British Columbia.

UDC 796.01-057.875(497)

ORIGINAL SCIENTIFIC PAPER

Health-Related Fitness Knowledge of Middle School Students in Public and Private Schools

Sakir Serbes[1], Cevdet Cengiz[1], Murvet Sivri[1] and Tugce Filiz[1]

Affiliations: [1]Canakkale Onsekiz Mart University, School of Physical Education and Sport, Department of Physical Education and Sports Teaching, Canakkale, Turkey

Correspondence: Sakir Serbes, Canakkale Onsekiz Mart University, School of Physical Education and Sport, Terzioglu Yerleskesi, 17100 Canakkale, Turkey. E-mail: sakirserbes@comu.edu.tr

ABSTRACT The purpose of this study is to examine public and private middle school students' levels of Health-Related Fitness Knowledge (HRFK) according to school type, gender, and grade. A cross-sectional survey method was applied in the research. A total of 334 public middle school students (n_{female} =154 and n_{male} = 180) and 386 private middle school students (n_{female} =187 and n_{male} = 199) participated in the survey. The data collection instrument was developed by Hunuk and Ince (2010) based on the "Superkids-Superfit Knowledge" study (Mott, Virgilio, Warren and Berenson, 1991). The data collected was analysed using the following descriptive and non-parametric tests: the Pearson chi-square, Mann-Whitney U-test, and Kruskal-Wallis H-test. Findings indicated a significant difference according to school type and age group ($p<.05$), but a non-significant difference according to gender and HRFK test result. Results improved year to year except among 7th graders. In other words, private middle school students' HRFK results were higher than those of public middle school students; grade level was also linked to HRFK, but gender was not. These results suggest that physical education curriculums should be developed with reference to HRFK objectives. Another recommendation would be that HRFK tools be customized by grade level in the Turkish context.

KEY WORDS Health-Related Fitness Knowledge, Middle School, Students, Physical Education.

@MJSSMontenegro
HEALTH-RELATED FITNESS KNOWLEDGE
http://mjssm.me/?sekcija=article&artid=128

Introduction

At present, it is understood that a significant contributing factor in the rise of chronic diseases such as obesity, cardiovascular disease, hypertension, diabetes and osteoporosis is a lack of physical activity (PA). Insufficient information about PA and its importance for well-being have contributed to a shift towards increasingly sedentary lifestyles (Centers for Disease Control and Prevention (CDC), 2004; United States Department of Health and Human Services [USDHHS], 2000). Gutin et al. (1992) define physical fitness (PF) as the ability to successfully perform necessary physical activities. PF involves both health-related and skill-related factors. Components of health-related physical fitness (HRPF) are considered to include cardiovascular endurance, muscular strength and endurance, body composition and flexibility, while components of performance-related physical fitness (PRPF) include (in addition to the above) agility, strength, speed and balance (Pate, 1983; Looney & Plowman, 1990; Gutin et al., 1992; Bouchard et al., 1994; Ozer, 2001). The relationship between physical activity and well-being has been the subject of research in several previous studies (e.g. Hardman & Stensel, 2009). In these studies, the frequency, severity, duration and type of PA required to maintain or improve individuals' health-related physical fitness levels are explored for each of these components (Hoffman, 2006).

It is known that individuals who regularly engage in physical activity become less sick, are more energetic, feel psychologically better, and experience better general health (Corbin & Lindsey, 1990; Corbin & Pangrazi, 1993). Several scientific studies have suggested that adolescents require at least one hour of physical activity daily in order to remain healthy (World Health Organization, 2010; Janssen & LeBlanc, 2010; Turkish Ministry of Health, Basic Healthcare Services General Directorate, 2011). It has also been observed that students' level of physical activity decreases significantly during adolescence (CDC, 2004; USDHHS, 2000). Hager (2006) points out that adults and children experience various health problems, including cardiovascular disease, as

Accepted after revision: June 24 2016 | First published online: March 01 2017

Conflict of interest: None declared.

a result of inactivity combined with an increase in energy intake. Van Sluijs et al. (2008) also submit that as a result of advanced technology, physical activity levels have decreased alarmingly and that immediate measures need to be taken. Since health problems result from decreased physical activity, and inadequate nutrition and stress increase with age, the negative impacts of these on states will be workforce loss, increased healthcare expenditures, and adversely affected national budgets. Globally, this situation has become one of the most critical education and healthcare policy priorities; developed and developing countries alike are encouraging people to cultivate healthy lifestyle habits (Turkish National Burden of Disease, 2004; WHO, 2010).

Recently, the Turkish physical education (PE) curriculum was updated with health-related objectives and standards (NASPE, 2004; MoNE, 2007, 2013). When the PE curriculums implemented at primary, middle, and high schools in Turkey are explored, it is observed that HRPF is included within the "Active and Healthy Living" learning domain for primary and middle schools, and within the "Personal Development and Healthy Living" sub-domain in the high school curriculum. Within the scope of HRPF domains and sub-domains, along with developing the habit of participating in physical activities eagerly and regularly, students are also expected to improve their knowledge of health-related physical fitness. (MoNE, 2009, 2013). Improving Health-Related Fitness Knowledge (HRFK) might be the first step in establishing healthy PA behaviours (Castelli & Williams, 2007; Keating et al., 2009a). HRFK is described as the knowledge of individuals' ability to perform PA and protect themselves from chronic diseases (Keating et al., 2009a).

Studies suggest that there are significant pieces of missing or faulty information in students' HRFK (Placek et al., 2001). Moreover, it is identified that the HRFK levels of primary and middle school students are well below the levels specified in the physical education learning objectives (Keating et al., 2009b). Another empirical study reports that minimal improvements have been made in students' HRFK levels, or in their cardiovascular endurance (Mott, Virgilio, Warren & Berenson, 1991). In a study conducted on African-American adolescents, Lewis-Moss et al. (2009) identified a meaningful relationship between health knowledge and actual exercise. Physical Fitness Knowledge scales were developed to evaluate middle and high school students by grade (Teatro, Kulinna, Zhu, Boiarskaia, & Wilde, 2013). In another study conducted on a sampling of high school students, male students reportedly found participating in exercise more meaningful in terms of well-being than female students did (Al-Amari & Ziab, 2012). Moreover, in the review article of Demetriou, Sudeck, Thiel, and Honer (2015), interventional HRFK designs were found to have high rates (79.4%) of success, especially among adolescents.

Research on HRFK for the Turkish context is limited and has mostly been undertaken in middle schools. Hunuk and Ince (2010) developed the Superkids-Superfit Knowledge Test according to Turkish physical education curriculum standards (MoNE, 2007) and validated the instrument for use in middle schools. Hunuk, Ince and Tannehill (2012) conducted empirical research with PE teachers and their middle school students using this tool; findings suggested that both groups improved HRFK test scores within six weeks of intervention. Another study by Cengiz and Ince (2014) in a rural middle school context revealed that the HRFK of students was improved with a 12-week social-ecologic experimental design. Improving school content in this rural area was effective in developing the health-related knowledge and behaviours of students. In a study by Tek (2015), the levels of both physical fitness and physical fitness knowledge among middle school students were compared. According to the findings, the HRFK levels of students were generally at the "pass" or "average" level. When Ince and Hunuk (2013) explored the subject from physical education teachers' perspectives, they found HRFK levels to be substantially insufficient (Castelli & Williams, 2007), with significant differences in knowledge levels and knowledge internalization processes among participating teachers. In addition, they pointed out that teachers were not successful in creating a physical education learning environment conducive to HRFK.

Research shows that HRFK can be effective in improving physical activity behaviour. The fact that studies conducted on this subject within Turkey are limited, and that students are not sufficiently informed with regard to HRFK, constitute the reason for this research. In the current study, middle school students' HRFK levels were examined with reference to the variables of school type, gender, and grade level. The study has been designed to provide information about the HRFK level of Turkish middle school students and their needs. The hypothesis is that middle school students' health-related fitness knowledge is low.

Methods

Participants

The study sample was selected from private and public middle schools in Canakkale, Turkey. Students were between 11 and 14 years old (n=720) and attended one of three private schools (Canakkale College, Ismail Kaymak College or Gokkusagi College (n_{female}=187; n_{male}=199)) or one of four state schools (Kepez Huseyin Akif Terzioglu, Anafartalar, Turgut Reis and Istiklal (n_{female}=154; n_{male}=180)). Participants' weight, height and body mass index (BMI) are recorded by gender in Table 1.

Data Collection Instruments

Health-Related Fitness Knowledge (HRFK) was tested using the translated version of the Super Kids-Superfit questionnaire (Mott et al., 1991). The Turkish version of this questionnaire was adapted according to the Turkish physical education curriculum for middle school HRFK standards (MoNE, 2007) and validated by Hunuk and Ince (2010). The Turkish version includes 36 items. According to the validation

UDC 796.01-057.87(560)

TABLE 1 Middle school students' descriptive statistics for height, weight and BMI

Grade	Variables	Public School				Private School			
		Female		Male		Female		Male	
		n	M±SD	n	M±SD	n	M±SD	n	M±SD
	Height (cm)		1.45±.07		1.48±.08		1.47±.08		1.51±.10
5	Weight (kg)	23	38.52±8.49	27	40.74±6.43	58	42.24±7.75	40	45.60±11.46
	BMI (kg/m^2)		18.16±2.64		18.57±2.53		19.44±3.27		19.70±3.05
	Height (cm)		1.51±.08		1.54±.10		1.55±.06		1.54±.07
6	Weight (kg)	41	41.68±7.59	52	44.90±9.18	39	49.28±10.68	56	48.25±10.68
	BMI (kg/m^2)		18.01±2.83		18.65±2.29		20.22±4.13		20.03±3.35
	Height (cm)		1.56±.08		1.59±.09		1.60±.07		1.62±.09
7	Weight (kg)	44	48.27±7.69	50	51.20±10.28	50	51.96±12.03	57	54.45±11.06
	BMI (kg/m^2)		19.73±2.32		20.08±3.12		19.96±4.05		20.48±2.88
	Height (cm)		1.62±.05		1.63±.11		1.64±.08		1.64±.05
8	Weight (kg)	46	51.39±7.39	51	57.45±13.38	40	53.95±7.70	46	56.71±6.81
	BMI (kg/m^2)		19.44±2.14		21.42±3.51		19.91±2.35		21.06±2.45

study, the item difficulty values ranges from 0.24 to 0.90, the average p-value of the test is 0.60, and the discrimination value range is 0.04–0.54. The reliability value of the test is 0.68. Based on these findings, the test is reported as a valid measure of Turkish middle school students' conceptual HRFK by Hunuk and Ince (2010).

Data Collection Procedure

Data was collected between late February and mid-May 2013. All questionnaires were administered during school hours by the physical education researcher either during the lunch break or after school. The questionnaire was explained by the researcher to the participants. Permission was granted by school administrators, principals, physical education teachers and Canakkale District National Education for ethical concerns. Informed written consent for participation and debriefing was also obtained from both students and their parents prior to the study.

Statistical Analysis

Descriptive statistics (frequencies and percentages) and non-parametric tests were used (the Mann-Whitney U-test and Kruskal-Wallis H-test) to organize data according to the variables of school type, gender, and grade. In addition, the Pearson chi-square analysis was used to correlate school type and HRFK test success ($p<0.05$). All statistical analysis was performed after checking normality assumptions (the Kolmogorov-Smirnov and Shapiro-Wilk tests), using the Statistical Package for Social Science (SPSS) for Windows. HRFK test scores were standardized on a 100-point scale according to the Ministry of National Education's subject grading system. Students' scores were rated as (5) very good (85–100), (4) good (70–84), (3) average (55–69), (2) pass (45–54), (1) fail (0–44).

Results

Among public middle school students, 46.1% (n=154) of participants in the study were female and 53.9% (n=180) were male. Among private school participants, 48.4% (n=187) were female and 51.6% (n=199) were male.

TABLE 2 Middle school students' correct answers with standardized scores and descriptive statistics in the HRFK test according to school type, grade, and gender

Grade	Variable	Public School				Private School			
		Female		Male		Female		Male	
		n	M±SD	n	M±SD	n	M±SD	n	M±SD
5	Correct Answer	23	18.73±3.95 55.21±11.87	27	19.11±4.73 56.37±14.11	58	23.89±3.38 70.39±9.83	40	21.02±5.03 61.90±14.75
6	Correct Answer	41	20.87±3.72 61.46±10.92	52	20.46±4.72 60.25±13.97	39	25.28±3.38 74.35±11.12	56	23.82±4.69 70.05±13.69
7	Correct Answer	44	20.90±4.32 61.54±12.70	50	20.18±5.02 59.34±14.81	50	25.02±3.91 73.60±11.33	57	25.12±4.31 73.82±12.55
8	Correct Answer	46	22.95±4.39 67.60±12.86	51	22.76±4.38 66.98±12.84	40	26.37±4.16 77.47±12.12	46	25.54±4.04 75.08±11.75

The mean, standard deviation (SD) and percentage of the students' HRFK test scores and standardized test scores were calculated and arranged according to school type, gender, and grade in Table 3. The results according to grade indicated that HRFK test scores increased by year except for the case of 7th-grade public school males (20.18±5.02; 59.34±14.81) and 7th-grade private school females (25.02±3.91; 73.60±11.33). In addition, private school students had higher HRFK test scores and higher standardized test scores for both genders and all grades than their public school counterparts.

TABLE 3 Middle school students' descriptive statistics in HRFK test components

Variable	Number of Questions	Public School (n=334)	Private School (n=386)
		M±SD	M±SD
Cardiovascular Endurance	10	6.07±1.94	7.39±1.52
Muscle Strength Endurance	4	2.37±0.89	2.77±0.84
Flexibility	4	2.12±0.97	2.53±1.00
Body Composition	3	1.49±0.89	1.72±0.81
Training Principles	6	3.57±1.33	4.16±1.36
General Health Knowledge	9	5.34±1.50	6.00±1.61

The findings indicated that for the HRFK components of cardiovascular endurance, muscle strength endurance, flexibility, body composition, training principles and general health knowledge, private school students scored higher than public school students did.

When the middle school students' correct answers and standardized scores from the HRFK were arranged by school type and gender, public school students (n=334) were shown to have lower scores (20.99±4.61) and standardized scores (61.81±13.59) than private school students' (n=386) scores (24.50±4.38; 72.08±12.76). In terms of gender, female students (n=341) had more correct answers (28±4.50) and higher standardized scores (68.53±13.15) than male students' (n=379) scores (22.51±5.06; 66.22±14.84).

Middle school students in private schools were more successful at all grade levels than their public school counterparts were. Higher percentages were evident among private middle school students (see Table 5).

The degree of correlation between test scores by school type was examined with the Pearson chi-square test. The analysis showed a significant difference [χ^2 (4, n=720)=100,36, p=.0001] in HRFK test scores by school type.

According to the Mann-Whitney U-test results, there was a significant difference in HRFK test scores by school type (z=-10.139, p<.05) but no significant difference according to gender (z=-1.521, p>.05).

Participants' HRFK test scores were examined by grade using the Kruskal-Wallis H-test, and a significant difference was observed between classes [χ^2 (3)=32.131, p=.000]. The Mann-Whitney U-test was also used to examine differences by grade. A significant difference was detected between grades 5–6 (z=-2.184, p<.05), 5–7 (z=-2.853, p<.05), 5–8 (z=-5.602, p<.05), 6–8 (z=-3.731, p<.05) and 7–8 (z=-2.695, p<.05). However, no significant difference was detected between grades 6–7 (z=-0.941, p>.05) (see Table 6).

Discussion

In this study, public and private middle school students' HRFK levels were examined by gender, class level and school type. According to the research findings, HRFK levels varied by school type, with private school students scoring higher than public school students. HRFK levels also differed significantly by grade level but not by gender.

TABLE 4 Middle school students' HRFK degree of test scores (MoNE) descriptive statistics based on school type

School Type	Degree of Test Scores					Total
	Fail	Pass	Average	Good	Very Good	
Public School	46	52	129	95	12	334
	13.8%	15.6%	38.6%	28.4%	3.6%	100.0%
	6.4%	7.2%	17.9%	13.2%	1.7%	46.4%
Private School	12	18	104	194	58	386
	3.1%	4.7%	26.9%	50.3%	15.0%	100.0%
	1.7%	2.5%	14.4%	26.9%	8.1%	53.6%
Total	58	70	233	289	70	720
	8.1%	9.7%	32.4%	40.1%	9.7%	100.0%
	8.1%	9.7%	32.4%	40.1%	9.7%	100.0%

UDC 796.01-057.87(560)

Dilorenzo and colleagues (1998) suggested that HRFK was one of the variables that determined exercise behaviours among middle school students. However, limited research has been conducted on this topic. PE teachers play a major role in conveying HRFK. Studies suggest that more than half of middle school students were unable to identify physical fitness activities and parameters, and some students also could not meet the physical fitness parameters of the Fitnessgram test (Kulinna, 2004; Meredith & Welk, 2004; Stewart & Mitchel, 2003).

TABLE 5 Middle school students' HRFK test scores analysis with Mann-Whitney U test based on school type and gender

	Variable	n	M±SS	z	p
School Type	Public School	334	61.81± 13.59	-10.139	.000*
	Private School	386	72.08±12.76		
Gender	Female	341	68.53±13.15	-1.521	.128
	Male	379	66.22±14.84		

Legend: *Significant level, p<0.05.

In our study, when middle school students' HRFK levels are assessed by grade using the Ministry of National Education assessment tools and success parameters, public school students scored at the intermediate level. Private school students scored at the advanced level. Tek (2015) found that public middle school students scored at the passing level, while students in higher grades scored at the intermediate level. Research outcomes for urban and rural public schools have usually been found to be similar in the Turkish context (Cengiz & Ince, 2014; Hünük, Ince & Tannehill, 2012).

TABLE 6 Middle school students' HRFK test scores and analysis with Mann-Whitney U-test based on class

Grades	n	M±SD	z	p
5-6	148	63.18±13,81	-2.184	.029*
	188	66.36±13,86		
5-7	148	63.18±13,81	-2.853	.004*
	201	67.47±14,46		
5-8	148	63.18±13.81	-5.602	.000*
	183	71.46±13.13		
6-7	188	66.36±13.86	-.941	.347
	201	67.47±14.46		
6-8	188	66.36±13.86	-3.731	.000*
	183	71.46±13.13		
7-8	201	67.47±14.46	-2.695	.007*
	183	71.46±13.13		

Legend: *Significant level, p <0.05.

In their empirical research conducted on PE teachers, Hunuk et al. (2012) suggest that training to improve the HRFK level in teachers allows knowledge development and that this change reflects on students. These findings show how important PE teachers are in conveying program accomplishments. The present study suggests private school students' higher HRFK might be related to PE teachers, school environment, and facilities. It is recommended that this subject also be explored using qualitative research methods. Based on the findings obtained in our research, private middle school students' HRFK success is higher than that of public middle school students. It is observed that the HRFK level of urban and rural public school students has increased as a result of changes in educational opportunity and the learning environment (Cengiz & Ince, 2014; Hunuk, Ince & Tannehill, 2012) and that they scored higher than private school students did.

Based on the available literature, it is seen that the number of studies exploring middle school students' HRFK level by gender and grade level is limited. In his research comparing middle school students' Physical Fitness Level (PFL) and HRFK, Tek (2015) suggests that students' HRFK levels do not differ by gender. These results are similar to those obtained from our study, which suggests that gender is not an important factor in middle school students' HRFK levels. In their research conducted at the high school level, Keating, Chen, Guan, Harrison, and Dauenhauer (2009a) surveyed secondary school students' HRFK and found that female students had higher scores than males did in the standardized HRFK test. The study also examined high school students' perceptions of issues relating to PE knowledge and health education; the findings revealed that students possessed a high level of awareness regarding the importance of PE to well-being. It was also reported that male students' views on participating in the exercise were more positive than those of female students (Al-Amari & Ziab, 2012). The results of the present study show that gender might have an impact on HRFK level, as might age.

The findings obtained in this study indicate that there were differences in HRFK between middle school students by grade. Tek (2015) reported in his research that the average number of correct answers among 8th graders was higher than those of students in other grades. He also reported that 5th-grade male students had the lowest average correct answers. Based on the findings of our research, the average HRFK scores of public and private school students improved by grade, except in the case of 7th-grade students. A decrease in average score was observed among 7th-grade public school males and 7th-grade private school females. It is recommended that 7th grade PE lessons be configured to improve HRFK levels. It should be noted that PE teachers, the quality of actual PE lessons, the number of hours spent in physical education (available as elective courses in middle schools), environmental factors and supplemental lessons might have an impact on the differences observed in middle school students' HRFK levels by grade. In a different study, the healthy living behaviours of 5th to 7th-grade students were examined, and significant differences in exercise behaviours were identified between grades; it was concluded that the healthy living scores of 5th and 6th-grade students were higher and statistically more significant than those of 7th-grade students (Hunuk, Gursel & Ince, 2007). In a qualitative study, Placek et al. (2001) suggested that exercise behaviours could be improved with HRFK. Moreover, it was indicated that middle school students had faulty knowledge about physical fitness and that they associated physical fitness with being very skinny. Findings of other research also reported similar results (Timothy et al., 2011; Kulinna, 2004; Stewart & Mitchel, 2003).

It is useful to note the limitations of the study when commenting on the results. The survey method used as a means of data collection is limited to the answers of the middle school students participating in the survey. A random sampling procedure with a large number of participants can be applied in future research for the purposes of generalization. Furthermore, the research findings were limited to those of Canakkale middle school students.

Conclusion

In conclusion, the research findings have shown that private middle school students' HRFK level was higher than that of public school students. Gender was not found to be influential on HRFK levels, but grade level was. Physical Education lessons should be planned with the goal of improving students' HRFK levels. To achieve this, professional development programs should be organized that are aimed at improving the knowledge levels and educational techniques of PE teachers (Hunuk, Ince, & Tannehill, 2012). In this way, program objectives will be achieved more easily through conceiving a more effective middle school PE training curriculum, as recently developed in accordance with a structured training approach. It is also recommended that HRFK tests that account for differences in grade level be developed for future studies. Moreover, an examination of pre-service PE teachers' HRFK levels during undergraduate education and how they utilize their knowledge might be presented as a general suggestion of this research.

REFERENCES

Al-Amari, H. & Ziab, A. (2012). Perception of high school students in Kuwait regarding their knowledge about physical education and the role of health education. *College Student Journal*, 46 (2), 308-313.

Bouchard, C., Shephard, R.J., & Stephans, T. (1994). *Physical Activity, Fitness, and Health: The Model and Key Concepts, "Physical Activity, Fitness and Health International Proceedings and Consensus Statement"*. Edited By Bouchard C., Shephard R.J., Stephans T. Human Kinetics, USA.

Castelli, D. & Williams, L. (2007). Health-related fitness and physical education teachers'content knowledge. *Journal of Teaching in Physical Education*, 26, 3-19.

Cengiz, C. & Ince, M.L. (2014). Impact of social-ecologic intervention on physical activity knowledge and behaviors of rural students. *Journal of Physical Activity and Health*, 11 (8), 1565-1572.

Corbin, C. & Lindsey, R. (1990). Concepts of Physical Fitness. 7th ed. Dubuque, LA: Brown.

Corbin, C. & Pangrazi, R. (1993). The health benefits of physical activity. *Physical Activity and Fitness Research Digest,* 1, 1-7.

Centers for Disease Control and Prevention (2004). The burden of chronic diseases and their risk factors: *National and State Perspectives*. Retrieved August 20, 2010, from http://www.cdc.gov/nccdphp/burdenbook2004/pdf/burden_book2004.pdf.

Demetriou, Y., Sudeck, G., Thiel, A., & Honer, O. (2015). The effects of school-based physical activity interventions on students' health-related fitness knowledge: A systematic review, *Educational Research Review*, 16, 19-40.

Dilorenzo, T.M., Stucky-Ropp, R.C., Vander Wal, J.S., & Gotham, H.J. (1998). Determinants of exercise among children: A longitudinal analysis. *Preventive Medicine*, 27 (3), 470-477.

Gutin, B., Manos, T., & Strong, W. (1992). Defining health and fitness, first step toward establishing children's fitness standarts. *Research Quarterly For Exercise and Sport,* 63 (2), 128-132.

Hager, R.L. (2006). Television viewing and physical activity in children. *Journal of Adolescent Health*, 39, 656-661.

Hardman, A.E. & Stensel, D.J. (2009). *Physical Activity and Health: The Evidence Explained*. Oxon, New York: Routledge.

Hoffman, J. (2006). *Norms for Fitness, Performance, and Health*. Champaign, IL: Human Kinetics.

Hunuk, D., Gursel, F. & Ince, M.L. (2007) An examination of the 5-7. grade elementary school students'

UDC 796.01-057.87(560)

healthy lifestyle behaviours. In *Proceedings of 4th annual congress of the International Mediterranean Sport Sciences (137)*. Antalya: International Mediterranean Sport Sciences.

Hunuk, D. & Ince, M.L. (2010). Development of health-related fitness knowledge test for Turkish middle school students. In *Proceedings of 15th Annual Congress of the European College of Sport Science (554-555).* Antalya: European College of Sport Science.

Hunuk, D., Ince, M.L., & Tannehill, D. (2012). Developing teachers' health-related fitness knowledge through a community of practice: impact on student learning. *European Physical Education Review*, 19, 3-20.

Ince, M.L. & Hunuk, D. (2013) Experienced physical education teachers' health-related fitness knowledge and knowledge inernalization processes. *Education and Science*, 38 (168), 304-317.

Janssen, I. & LeBlanc, A.G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity*, 7, 40.

Keating, X.D., Chen, L., Guan, J., Harrison, L., & Dauenhauer, B. (2009a). Urban minority ninth-grade students' health-related fitness knowledge. *Research Quarterly for Exercise and Sport*, 80, 747-755.

Keating, X.D., Harrison, L. Chen, L., Xiang, P., Lambdin, D., Dauenhauer, B., Rotich, W., & Pinero, J.C. (2009b). An analysis of research on student health-related fitness knowledge in K-16 physical education programs. *Journal of Teaching in Physical Education*, 28, 333-349.

Kulinna, P.H. (2004). Physical activity and fitness knowledge: how much 1-6 grade students know. *International Journal of Physical Education*, XLJ, 111–121.

Lewis-Moss, R.K., Paschal, A., Sly, J., Roberts, S., & Wernick, S. (2009). Assessing the health knowledge, attitudes and behaviors of midwestern *African American adolescents. American Journal of Health Studies*, 24 (1), 204-248.

Looney, M.A. & Plowman, S.A. (1990). Passing rates of American children and youth on the FITNESSGRAM criterion-referenced physical fitness standards. *Research Quarterly for Exercise and Sport*, 61 (3), 215-223.

Ministry of National Education (MoNE) (2007). Primary Physical Education Curriculum. Ankara: Ministry of Education Publication.

Ministry of National Education (MoNE) (2009). Elementary Physical Education Curriculum (1-8. Grades). Ankara: Ministry of Education Publication.

Ministry of National Education (MoNE) (2013). Physical Education Curriculum (Middle school 5-8. Grades). Ankara: Ministry of Education Publication.

Meredith, M., & Welk, G. (2004). *Fitnessgram. Activitygram. Test Administration on Manual. 3rd ed.* Dallas, TX: The Cooper Institute.

Mott, D.S., Virgilio, S.J., Warren, B.L., & Berenson, G.S. (1991). Effectiveness of a personalized fitness module on knowledge, attitude, and cardiovascular endurance of fifth-grade students 'Heart Smart'. *Perceptual and Motor Skills,* 73, 847–858.

National Association for Sport and Physical Education (NASPE) (2004). Moving into the future: National standards for physical education (2nd ed.). Reston, VA: AAHPERD, 1-49.

Ozer, M.K. (2001). *Fiziksel Uygunluk*. Nobel Yayın Dağıtım, Ankara.

Pate, R.R. (1983). *Health Fitness, "Physical Education and Sport for the Secondary School Student"*. Edited by Dougherty N.J., et al., Sponsored by NASPE an association of AAHPERD.

Placek, J.H., Griffin, L.L., Dodds, P., Raymond, C., Tremino, F., & James, A. (2001). Middle school students' conceptions of fitness: the long road to a healthy lifestyle. *Journal of Teaching Physical Education*, 20 (4), 314-323.

Stewart, S. & Mitchell, M. (2003). Instructional variables and student knowledge and conceptions of fitness. *Journal of Teaching Physical Education*, 22, 533-551.

Teatro, C., Kulinna, P.H., Zhu, W., Boiarskaia, E., & Wilde, B. (2013). Secondary students' healthy behavior knowledge: An update. *Research Quarterly for Exercise and Sport*, 84(1), A-30 (abstract).

Timothy, B., Kulinna, P.H., & Cothran, D. (2011). Health and physical activity content knowledge of Pima children. *Physical Educator*, 68, 66–77.

Tek, B.N. (2015) *The Comparison of Physical Fitness Knowledge and Physical Fitness Levels of Middle School Students, Health Science Institute*. Unpublished Masters Thesis. Canakkale, Turkey, Canakkale Onsekiz Mart University.

Turkish National Burden of Disease (2004). *Turkish National Burden of Disease Study Report*. Turkish Republic Ministry of Health Refik Saydam Institute and Baskent University.

Turkish Ministry of Health, Basic Healthcare Services General Directorate. (2011). *Türkiye'de okul çağı çocuklarında (6-10 yaş grubu) büyümenin izlenmesi (TOCBG) projesi araştırma raporu*. Turkish Republic Ministry of Health Publication, Ankara.

United States Department of Health and Human Services (2000). *Physical activity and health: a report of the surgeon general.* Centers for Disease Control and Prevention and Health promotion: Atlanta, GA.

Van Sluijs, E.M., Skidmore, P.M., Mwanza, K., Jones, A.P., Callaghan, A.M., Ekelund, U., Harrison, F., Harvey, I., Panter, J., Wareham, N.J., Cassidy, A., & Griffin, S.J. (2008). Physical activity and dietary behaviour in a population-based sample of British 10-year old children: the SPEEDY study (Sport, Physical activity and Eating behaviour: Environmental Determinants in Young people). *BMC Public Health*, 14 (8), 388.

World Health Organization (2010). *Global Recommendations on Physical Activity for Health.* WHO Press, Geneva, Switzerland.

ORIGINAL SCIENTIFIC PAPER

Stature and Its Estimation Utilizing Arm Span Measurements in Male Adolescents from Federation of Bosnia and Herzegovina Entity in Bosnia and Herzegovina

Jovan Gardasevic[1], Faris Rasidagic[2], Dragan Krivokapic[1], Marin Corluka[3] and Dusko Bjelica[1]

Affiliations: [1]University of Montenegro, Faculty for Sport and Physical Education, Niksic, Montenegro, [2]University of Sarajevo, Faculty of Sport and Physical Education, Sarajevo, Bosnia and Herzegovina, [3]University of Mostar, Faculty of Science and Education, Mostar, Bosnia and Herzegovina

Correspondence: Jovan Gardasevic, University of Montenegro, Faculty for Sport and Physical Education, Narodne omladine bb, 81400 Niksic, Montenegro. E-mail: jovan@ac.me

ABSTRACT The purpose of this study was to evaluate stature in males from the Federation of Bosnia and Herzegovina Entity in Bosnia and Herzegovina (hereinafter BH) as well as the relationship between arm span as an alternative to estimating stature, which varies in different ethnic and racial groups. The nature and scope of this study analyse 193 male students (aged 20.84±2.08) from the University of Sarajevo and University of Mostar. Anthropometric measurements were used in accordance with the protocol of the ISAK. Means and standard deviations were obtained. Statures and arm spans were compared using a t-test. The relation between arm span and stature were determined using simple correlation coefficients and a confidence interval of them of 95%. A linear regression analysis was then executed to examine the extent to which stature can be reliably predicted by arm span. The results have shown that males from the Federation of Bosnia and Herzegovina Entity are 183.84±6.41 cm tall and have an arm span of 185.65±7.55 cm. In comparison to other studies, the results of this one show the BH population to be one of the tallest nations in the world, perhaps the tallest one. Moreover, arm span surely predicts stature in males (61.6%). However, the estimation equations, which were obtained in Bosnian Herzegovinians from mentioned entity, are substantially different alike in the population from other entities, since arm span was not close to statures (1.81±1.14 cm more than the stature). This confirms the need for developing individual height models for this population.

KEY WORDS Prediction, Body Height, Arm Span, Bosnia and Herzegovina.

@MJSSMontenegro
STATURE AND ARM SPAN MEASUREMENTS IN MALE ADOLESCENTS
http://mjssm.me/?sekcija=article&artid=129

Introduction

The Republic of Bosnia and Herzegovina (hereinafter BH) as an independent and democratic state has a parliamentary system made of several different political parties. The governmental system is based on the division of power into legislative, executive and judiciary branches, and it has a bicameral legislature, and a three-member presidency constituted of a member of every major ethnic group (Bosniaks, Serbs, and Croats). The country, largely decentralized with highly limited central governmental power, is composed of two autonomous entities: the Federation of BH and Republic of Srpska, with the Brcko District as a third region, run under local government. This country declared independence in 1992 as one of the inheritor states of the former Yugoslavia. Despite being one of the youngest states in the world, this is a region which finds permanent human settlement back to the Neolithic age. It was populated by several Illyrian and Celtic civilizations. From the 6th to the 9th centuries AD Slavic peoples settled this area. This is why BH has very rich history, one of the richest in the region, culturally, socially and politically.

This area was occupied by the Ottoman Empire from the mid-15th to the late 19th centuries, after which

Accepted after revision: September 18 2016 | First published online: March 01 2017

Conflict of interest: None declared.

it were under the Austro-Hungarian Empire, which lasted up until the World War I. BH was a part of the Kingdom of Serbs, Croats and Slovenes (from 1929 the Kingdom of Yugoslavia) until World War II, after which the country became a republic in a newly formed Socialist Federal Republic of Yugoslavia. Hence, this country has been one the largest crossroads of historic empires.

Nowadays, the Republic of BH covers an area of 51,197 km² (Central Intelligence Agency, 2014). It is in South-eastern Europe, on the Balkan Peninsula. It is bordered by Serbia to the east, Croatia to the north, west, and south, and Montenegro to the south-east, and it has 20 kilometres of coastline on the Adriatic Sea, around the town of Neum in the Herzegovina-Neretva Canton. Being surrounded by Croatian peninsulas, BH has rights of passage to the outer sea, per international law. The central and southern interior of the country is mountainous, the north-west is moderately hilly, and the northeast is predominantly flatland. The name of the country comes from two regions: Bosnia and Herzegovina. The border between them is not clearly defined. Bosnia occupies approximately four-fifths of the country, the north part, while Herzegovina occupies the rest. The country is mostly mountainous, encompassing the central Dinaric Alps. The Pannonian basin borders the north-eastern parts, while the Adriatic Sea borders it in the south. Dinaric Alps generally run in an east-west direction and rise towards the south. Overall, water covers less than 1%, while forest covers approximately 50% of the country. Herzegovina has dry Mediterranean climate in comparison to Bosnia where most forest areas are in the central, eastern and western parts. Northern Bosnia (Posavina) is very fertile agricultural land, which spreads along the River Sava; ir is heavily farmed. This farmland is a part of the Parapannonian Plain extending into neighbouring Croatia and Serbia.

There are three ethnic "constituent peoples in BH": Bosniaks, Serbs, and Croats. According to the 1991 census, BH had a population of 4,377,000 inhabitants (Institute for Statistics of Federation of BH, 2014); the 1996 UNHCR unofficial census showed a decrease to 3,920,000 inhabitants (Institute of International Cooperation of the German Adult Education Association, 2014). The Yugoslav wars in the 1990s caused large migrations of the population which have led to demographic shifts in the country. No census has was undertaken during war time, and political disagreements made it impossible to organize one later. A census planned for 2012 was delayed until 2014. The total population of the Republic of BH, by the 2014 census, was 3,871,643 inhabitants (Central Intelligence Agency, 2014). According to data collected by the Central Intelligence Agency (2014), the ethnic constitution of BH is Bosniaks 52.5 per cent of the population, Serbs 33.5 per cent, Croats 14 per cent, and around 1 per cent the others. Per the same source, Muslims account for 40 per cent of the population, Orthodox Christians 31 per cent, 15 per cent as Roman Catholics, and the rest (14 per cent) are others (atheists, Jews, and others). As ethnicity mostly corresponds to the religious affiliations, it is assumed that these differences are primarily based on religious backgrounds, and it is not based on biological facts. As this is a very sensitive question in BH, further analyses must take care with this conclusion.

The Dinaric Alps was recognized as an area with tall people by European anthropologists more than 100 years ago (Pineau, Delamarche, & Bozinovic, 2005). Bearing in mind that the modern BHs, like the other nations from Former Yugoslavia, fall more into the Dinaric racial classification than any other, the researchers of this study assumed that male BH adults may be a bit taller or equally tall than the tallest nations in the Europe (Bjelica, Popovic, Kezunovic, Petkovic, Jurak, & Grasgruber, 2012; Popovic, Bjelica, Molnar, Jaksic, & Akpinar, 2013; Popovic, Bjelica, Doina Tanase, & Milasinovic, 2015): BHs (183.9 cm; sampled in Republic of Srpska), Dutch (183.8 cm), Montenegrins (183.21 cm) and Serbians (182 cm). The researchers of this study believed that the BH population may be the tallest in the world. This is mostly because most the of previous studies analysed all the nations that have been contained in the sample of Pineau and collaborators (Bjelica et al., 2012; Popovic et al., 2013; Popovic et al., 2015; Popovic, Bjelica, Geogiev, Krivokapic, & Milasinovic, 2016), excluding the Federation of BH Entity in BH. However, previously analysed nations did not reach the height that Pineu and his collaborators (2005) confirmed. Because of that, the population from the Federation of BH Entity in BH may be the population that increased the average stature of the Dinaric Alps population measured by Pineu and his collaborators (2005). However, there are no available records from this region, unlike most other countries in Western Europe, and an update of average statures among its populations is beneficial as well as its estimation utilizing arm span measurements, mostly because that measurement of stature is significant in many context (Bjelica et al., 2012).

A well-established fact in the scientific literature is the importance of the measurement of stature in many contexts: as a measure of body size and an assessment of nutritional status (Datta Banik, 2011), an important measure for determining the basic energy requirements, also standardization of measures of physical capacity and adjusting drug dosage, evaluation of children's growth, prediction and standardization of physiological variables such as muscle strength, lung volumes, glomerular filtration and metabolic rate, etc. (Golshan, Amra, & Hoghoghi, 2003; M. Golshan, Crapo, Amra, Jensen, & R. Golshan, 2007; Mohanty, Babu, & Nair, 2001; Ter Goon, Toriola, Musa, & Akusu, 2011). However, there are many situations (i.e. conditions) where the exact stature cannot always be determined the usual way, for example, paralysis, amputation, fractures, scoliosis, or pain (Quanjer, Capderou, Mazocioglu, Aggarwal, Popovic, Datta Banik, Tayie, Golshan, Ip, & Zelter, 2014). In such situations, estimation of stature has to be derived from other reliable anthropometric indicators such as hand and foot lengths (A.K. Agnihotri, Purwar, Googoolybe, S. Agnihotri, & Jeebun, 2007; A.K. Agnihotri, S. Agnihotri, Jeebun, & Googoolye, 2008; Kanchan, Menezes, Moudgil, Kaur, Kotian, & Garg, 2008; Rastogi, Nagesh, & Yoganarasimha, 2008; Sanli, Kizilkanat, Boyan, Ozsahin, Bozkir, Soames, Erol, & Oguz, 2005; Uhrova, Benus,

UDC 572.512-053.8(497.6)

Masnicova, Obertova, Kramarova, Kyselicova, Dornhoferova, Bodorikova, & Nescakova, 2015), knee height (Fatmah, 2010; Fogal, Franceschini, Priore, Cotta, & Ribeiro, 2015; Hickson & Frost, 2003; Karadag, Ozturk, Sener, & Altuntas, 2012), length of the forearm (Ilayperuma, Nanayakkara, & Palahepitiya, 2010), length of the sternum (Menezes, Kanchan, Kumar, Rao, Lobo, Uysal, Krishan, Kalthur, Nagesh, & Shettigar, 2009; Menezes, Nagesh, Monteiro, Kumar, Kanchan, Uysal, Rao, Rastogi, Lobo, & Kalthur, 2011), vertebral column length (Nagesh & Pradeep, 2006), sitting height (Fatmah, 2010), length of scapula (Campobasso, Di-Vella, & Introna, 1998), arm span (Aggrawal, Gupta, Ezekiel, & Jindal, 2000; Bjelica et al., 2012; Bubanja, Vujovic, Tanase, Hadzic, & Milasinovic, 2015; Datta Banik, 2011; Fatmah, 2010; Hickson & Frost, 2003; Jalzem & Gledhill, 1993; Mohanty et al., 2001; Popovic et al. 2015; Ter Goon et al., 2011; Vujovic, Bubanja, Tanase, & Milasinovic, 2015) as well as cranial sutures (Rao, Sowmya, Yoganarasimha, Menezes, Kanchan, & Aswinidutt, 2009), skull measurements (Bidmos, 2006; Bidmos & Asala, 2005), facial measurements (Sahni, Sanjeev, Sharma, Harjeet, Kaur, & Aggarwal, 2010) and others. Therefore, in predicting age-related loss in stature, all these anthropometric indicators used as an alternative to estimate stature are crucial. Because of mobility problems and kyphosis (Hickson & Frost, 2003) it is difficult and sometimes impossible to measure precisely the stature of individuals with stature loss while having surgical procedures on the spine (Mohanty et al., 2001) or disproportionate growth abnormalities and skeletal dysplasia, as well as predicting stature with many older people.

Due to all the aforementioned, the researchers trusted it would be reasonable to find the effectiveness of using various body indicators while the estimating stature in BHs. Even though there is a study which covers just the Republic of Srpska entity (Popovic et al., 2015), it is more than necessary to conduct the same study in Federation of BH Entity as this update would fit a missing part of the picture from entire BH and its ethnic groups. Moreover, several studies have presented the effectiveness of using various body parameters in predicting stature and arm span as the most reliable one (Hickson & Frost 2003; Jalzem & Gledhill 1993; Mohanty et al., 2001; Ter Goon et al., 2011). Nevertheless, the associations of arm span and stature was found to differ in different ethnic and racial groups (Bjelica et al., 2012; Brown, Feng, & Knapp, 2002; Reeves, Varakamin, & Henry, 1996; Popovic et al., 2013; Steele & Chenier, 1990; Popovic et al., 2015), while the study conducted by Quanjer et al. (2014) reported that the arm span/height ratio changes non-linearly with age and varies between males and females. Although several studies of this nature are related to Dinaric Alps populations, there are very limited data on BH subjects and no studies conducted in the Federation of BH Entity where various ethnic groups live. In the light of rather poor recent scientific literature, the goal of this study was to examine the stature with BH adult males (Federation of BH Entity) and the relationship between arm span and stature.

Methods

The nature and scope of this study encompass 193 male students from the University of Sarajevo and University of Mostar as subjects. The students were chosen because the growth of an individual ceases by this age and because there is no age-related loss in stature at this age. Although university-educated persons, according to Bjelica et al. (2012) are taller in comparison to the general population in Poland (Kułaga, Litwin, Tkaczyk, Palczewska, Zajączkowska, Zwolińska, Krynicki, Wasilewska, Moczulska, Morawiec-Knysak, Barwicka, Grajda, Gurzkowska, Napieralska, & Pan, 2011; Wronka & Pawlińska-Chmara, 2009), and Hungary (Bodzsár & Zsákai, 2008; Eiben & Tóth, 2000; Szöllősi, 1998), but not in Montenegro (Bjelica et al., 2012, Popovic et al., 2014), the researchers also believed this sample might fairly represent the whole population of the Federation of BH Entity. The average age of the subject was 20.84±2.08 years old (range 18-31 yrs.). It should be emphasized that the researchers did not accept students with physical deformities that would affect stature or arm span, and those without informed consent were not included in the study. The exclusion criterion was also not having BH citizenship. Accordingly, the researchers have purposely selected (deliberate sampling) the students from the University of Sarajevo and University of Mostar.

Although photogrammetric anthropometry is precise nowadays, it is not valid for measurement of arm span (Penders, Brecheisen, Gerver, Van Zonneveld, & Gerver, 2015); the anthropometric measurements, including stature and arm span, were taken according to the protocol of the International Society for the Advancement of Kinanthropometry (ISAK) (Marfell-Jones et al., 2006). The trained anthropometrist (the same one for each measure) whose quality of performance was evaluated according to the prescribed "ISAK Manual" prior to the study performed these measurements. The age of the students was determined directly from the date of birth they reported.

Using Statistical Package for Social Sciences (SPSS) version 20.0, the analysis was performed. Means and standard deviations (SD) were obtained for both anthropometric variables. A comparison of means of statures and arm spans was carried out using a t-test. The relationships between stature and arm span were determined using simple correlation coefficients and a 95% confidence interval. For examining the extent to which arm span can reliably predict stature, a linear regression analysis was performed. Finally, these relationships were plotted as scatter diagrams. Statistical significance was set at $p<0.05$.

Results

A summary of the anthropometric measurements is shown in Table 1. The mean value of the arm span for subjects was 185.65±7.55 cm, which was 1.81±1.14 cm more in comparison to the stature, and statistically significant ($t=5.343$, $p=0.000$).

TABLE 1 Anthropometric Measurements of the Study Subjects

Subject	Age (Mean±SD)	Stature Range (Mean±SD)	Arm Span Range (Mean±SD)
Male	18-31 (20.84±2.08)	169.0-205.4 (183.84±6.41)	170.0-213.4 (185.65±7.55)

The simple correlation coefficient and the 95% confidence interval analysis between the anthropometric measurements are presented in Table 2. High and significant relationships were found between stature and arm span in the sample.

TABLE 2 Correlation between stature and Arm Span of the Study Subjects

Subject	Correlation Coefficient	95% confidence interval	Significance p-value
Male	0.785	0.689-0.850	<0.000

The results of the linear regression analysis are shown in Table 3. The first models were derived by including age as a covariate. However, after it was found that age was insignificant, it was dropped, and estimates were gained as univariate analysis. The high values of the regression coefficient signify that arm span significantly predicts stature in males from the Federation of BH Entity in BH.

A scatter diagram shows the relationships between measurements of arm span and stature among the above model.

TABLE 3 Results of Linear Regression Analysis Where Arm Span Predicts Stature

Subject	Regression Coefficient	Standard Error	R-square (%)	t-value	p-value
Male	0.785	3.980	61.6	17.505	0.000

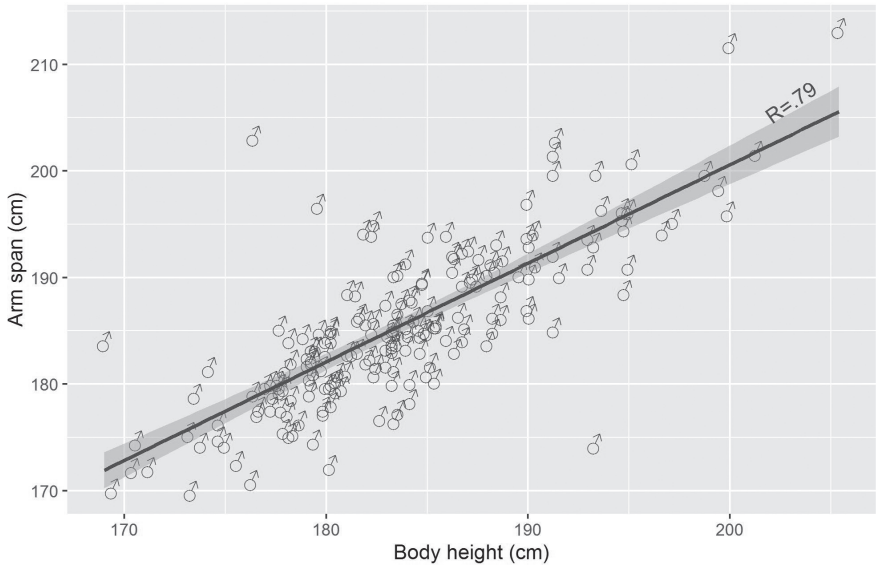


FIGURE 1. Scatter diagram and relationship between arm span measurements and body height among

Discussion

This study contributes to a major update of average statures among males from the Federation of BH Entity in BH. The results proved that males from that entity are very tall with an average of 183.84 cm, and this is within the range of the men from the other entity from BH who are 183.87 cm tall (Popovic et al., 2015), which is slightly more in comparison to the tallest nations in the Europe: the Dutch male population at 183.8 cm, which was measured in the last nationwide survey in 2010 (TNO, 2010), the Montenegrin male population at 183.74 cm measured in 2013 (Popovic, Bjelica, & Hadzic, 2014) and the Serbian male population measured in 2012 at 182 cm (Popovic et al., 2013). Consequently, the average height of BHs from the Federation of BH Entity is also taller than the 181.3 cm of the Lithuanians (Tutkuviene, 2005), the 180.6 cm of the Icelanders (Dagbjartsson, Hornórsson, Pálsson, & Arnórsson, 2000), the Croats at 180.5 cm (Juresa, Musil, & Tiljak, 2012), the Swedes at 180.4 cm (Werner & Bodin, 2006), the Slovenes at 180.3 cm (Starc & Strel, 2011), Danes (Statistics Denmark, 2011) and Czechs (Vignerová, Brabec, & Bláha, 2006) as

UDC 572.512-053.8(497.6)

well as several more nation that are taller than 180 cm. Consequently, BH males are the tallest in the world. Furthermore, there is a hypothesis that the male gender of BHs has not reached their full genetic potential yet since they have been influenced by various environmental factors (wars, poor economic situation, etc.) in recent few decades. Therefore, the researchers believe that these circumstances had a negative effect on the secular trend in BH as well as neighbouring countries such as Serbia, Montenegro and Macedonia (Bjelica et al., 2012; Popovic et al., 2013, Popovic et al., 2016), while it is expected that the secular changes which affect height are going to rise in the following two decades, in comparison to developed countries where this trend has already been completed.

To have a better perspective of the tallest nations around the world, the researchers have prepared Table 4 to give an overview of the top 10 tallest male populations in the world (the most of them are data from the national surveys).

TABLE 4. An Update of the Top 10 Tallest Male Nations in the World

#	*Country*	*Average* Stature	*Source*
1	Bosnia & Herzegovina	183.9	Popovic et al., 2015
1a	Bosnia & Herzegovina	183.8	Current study
2	Netherland	182.4	Statistics Netherland, 2015
3	Montenegro	183.2	Bjelica et al., 2012
4	Serbia	182.0	Popovic et al., 2013
5	Lithuania	181.3	Tutkuviene, 2005
6	Estonia	180.9	Kaarma et al., 2008
7	Iceland	180.6	Dagbjartsson et al., 2000
8	Croatia	180.5	Juresa et al., 2012
9	Sweden	180.4	Werner and Bodin, 2006
10	Slovenia	180.3	Starc and Strel, 2011

It is also interesting to note that the density of very tall subjects appears to be characteristic of the males from the Federation of BH Entity in BH (Figure 1) since 18.1% measured 190 cm or more in stature. If the 18.1% in Federation of BH Entity in BH (20.2% in Republic of Srpska entity in BH) would be compared to the 28% in Dinaric Alps (Pineau et al., 2005), 20% in the Netherlands (Pineau et al., 2005), 14% in Serbia (Popovic et al., 2013), 13% in Montenegro (Bjelica et al., 2012) and only 1.5% in France (Pineau et al., 2005), it would confirm that the denseness of very tall subjects in BH males is a fact, but less so than in the Dinaric Alps in general, according to the conclusions reached in Pineu and collaborator's study (2005). Therefore, the critical questions of who people are who increased the denseness of very tall subjects in Pineu and collaborator's study remains open, as most of the nations are excluded.

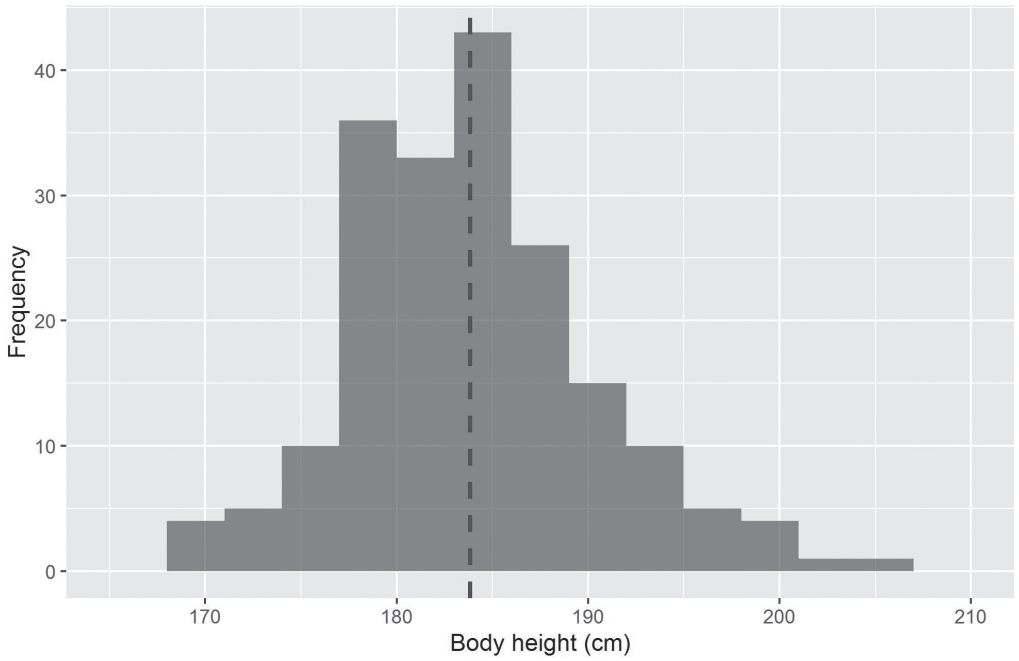


FIGURE 2. Density of Stature

Estimating the stature using various anthropometric measurements is an age-old investigation used previous centuries, and many researchers have attempted it. As already brought up, stature have been estimated from various anthropometric measurements by all of them, but it is important to underline that the arm span has been derived as being the most reliable body indicator for prediction stature of an individual (Mohanty et al., 2001; Ter Goon et al., 2011). However, it must be emphasized that the individual, as well as ethnic variations in respect of the relation og stature with arm span, were observed in European (Reeves et al., 1996) and African populations (De Lucia, Lemma, Tesfaye, Demisse, & Ismail, 2002), while Mohanty et al. (2001) have agreed that the estimating equation varies from race to race, and ethnic group to ethnic group. In Steele and Chenier's study (1990), arm span was almost 8.3 cm longer than stature for the black population (105.36% stature), where for the white population this difference was only 3.3 cm (102.04% stature). In Ter Goon et al.'s study (2011), arm span was 5.8 cm longer than stature for Nigerian males (103.3% stature). The latest studies run by Bjelica et al. (2012) showed that arm span was 2.5 cm longer than stature for Montenegrin males (101.4% stature) and Popovic at al. (2013) that showed that arm span was 2.8 cm longer than stature for Serbian males (101.5% stature), while Quanjer et al. (2014) have highlighted the stature and arm-span-to-height ratio may differ by up to 10% from actual stature. All the abovementioned have confirmed again the necessity for developing individual height models for each population on account of ethnic differences, while some recent studies found the regional differences among the same ethnic groups (Bubanja et al., 2015; Milasinovic, Popovic, Matic, Gardasevic, & Bjelica, 2016; Milasinovic, Popovic, Jaksic, Vasiljevic, & Bjelica, 2016; Vujovic et al., 2015), which cause the need for additional caution.

Because Bosnia and Hercegovina has two regions (entities) and three different ethnic groups, the main goal of the current study was to determine if these facts are true for the males from Federation of BH Entity in BH, since it is known that the estimating calculation varies from race to race, and ethnic group to ethnic group (Mohanty et al., 2001). Therefore, in this study, it is observed that the arm span was 1.81 cm longer than stature among men (100.3% stature). The arm span/height ratio in males from the Federation of BH Entity in BH is quite low when compared with other Europeans, but it is very close to the data reached when measuring the Montenegrin (Bjelica et al., 2012), Serbian (Popovic et al., 2013) and Macedonian populations as well as the other entity from BH (Popovic et al., 2015). It might be assumed that these similarities in body composition are caused by the joint genetic background of these nations.

The results of the aforementioned studies are also very similar to the correlation found in the present study (r=0.78). For example, Mohanty et al. (2001) observed the correlation r=0.82, while the correlation in Hickson and Frost's study (2003) was r=0.86, in Zverev's study (2003) it was r=0.87 for males population. In more recent studies, Ter Goon et al. (2011) reported the correlation r=0.83, while Bjelica et al. (2012) reported r=0.86, Popovic et al. (2013; 2015) reported the correlation high (r=0.81; r=0.88). Because the relation between arm span and stature is high and significant in the study sample, the arm span measure is apparently a reliable indirect anthropometric measurement used for estimating stature in males from the Federation of BH Entity in BH. As similar as these relations are, the estimation equations, obtained in the study population, might be substantially different from the population in another entity in BH as well as in other populations.

Although the results of this study confirm the need for developing individual height models for each population on account of ethnic differences, it must be emphasized that further research should use larger samples for the projection of stature using arm span measurement, mostly because this study as well as some other studies have used quite small samples. A more precise estimation of the average stature and its prediction using arm span measurements with BH adults would require a large sample with sufficient geographical and social heterogeneity (various ethnic groups), or a national survey that measures the whole population. Furthermore, in addition to the small sample, another limitation of this research study was the composition of the measured university students. Since university-educated persons have been proved to be taller than the rest of the population in Poland and Hungary, unlike in Montenegro, the possibility that the stature of the students somewhat overvalues the average stature of contemporary BH cannot be excluded. Furthermore, it is imperative to highlight that body proportion measurement using photogrammetric anthropometry, while nowadays accurate, is not valid for arm span measurement; keeping the old-fashioned method of measuring this body proportion is recommended.

REFERENCES

Aggrawal, A.N., Gupta, D., Ezekiel, L.M., & Jindal, S.K. (2000). Statistical estimation of height from arm span in north Indian subjects. *Indian Journal of Physiological Pharmacology*, 44(3), 329-334.

Agnihotri, A.K., Purwar, B., Googoolybe, K., Agnihotri, S., & Jeebun, N. (22007). Estimation of stature by foot length. *Journal of Forensic and Legal Medicine*, 14(5), 279–283.

Agnihotri, A.K., Agnihotri, S., Jeebun, N., & Googoolye, K. (2008). Prediction of stature using hand dimensions. Journal of Forensic and Legal Medicine, 15(8), 479-482.

Bidmos, M., & Asala, S. (2005). Calcaneal measurement in estimation of stature of South African blacks. *American Journal of Physical Anthropology*, 126(3), 335-342.

Bidmos, M. (2006). Adult stature reconstruction from the calcaneus of South Africans of European descent. *Journal of Clinical Forensic Medicine*, 13(5), 247-252.

UDC 572.512-053.8(497.6)

Bjelica, D., Popović, S., Kezunović, M., Petković, J., Jurak, G., & Grasgruber, P. (2012). Body Height and Its Estimation Utilizing Arm Span Measurements in Montenegrin Adults. *Anthropological Notebooks*, 18(2), 69–83.

Bodzsár, É., & Zsákai, A. (2008). Secular changes in the pattern of growth in Hungarian children (in Hungarian). *Anthropologiai Közlemények*, 49, 75-95.

Brown, J.K., Feng, J.Y., & Knapp, T.R. (2002). Is self-reported height or arm span a more accurate alternative measure of height? *Clinical Nursing Research*, 11(4), 417-432.

Bubanja, M, Vujovic, D., Tanase, G.D., Hadzic, R. & Milasinovic, R. (2015). Stature and Its Estimation Utilizing Arm Span Measurements in Female Adolescents from Central Region in Montenegro. *Sport Mont*, 12(43-45), 277-282.

Campobasso, C.P., Di-Vella, G., & Introna, F. (1998). Using scapular measurements in regression formulae for the estimation of stature. *Bollettino dellà Societa Italiana di Biologia Sperimentale*, 74(7/8), 75-82.

Dagbjartsson, A., Thornórsson, A.V., Pálsson, G.I., & Arnórsson, V.H. (2000). Height and weight of Icelandic children 6-20 years of age (In Icelandic). *Laeknabladid*, 86(7/8), 509-514.

Datta Banik, S. (2011). Arm span as a proxy measure for height and estimation of nutritional status: A study among Dhimals of Darjeeling in West Bengal India. *Annals of Human Biology*, 38(6), 728–735.

De Lucia, E., Lemma, F., Tesfaye, F., Demisse, T., & Ismail. S. (2002). The use of armspan measurement to assess the nutritional status of adults in four Ethiopian ethnic groups. *European Journal of Clinical Nutrition,* 56(2), 91–95.

Eiben, O.G., & Tóth, G. (2000). Half-a-century of the "Körmend Growth Study". *Collegium Antropologicum*, 24(2), 431-441.

Fatmah. (2010). Validation of predicted height model based on arm span, knee height and sitting height in Indonesian elderly people. *Journal of Clinical Medicine and Research*, 2(5), 67-73.

Fogal, A.S., Franceschini, S.D.C., Priore, S.E., Cotta, R.M.M. & Ribeiro, A.Q. (2015). Stature estimation using the knee height measurement amongst Brazilian elderly. *Nutricion hospitalaria*, 31(2), 829-834.

Golshan, M., Amra, B., & Hoghogi, M.A. (2003). Is arm span an accurate measure of height to predict pulmonary function parameters? *Monaldi Archives for Chest Disease*, 59(3), 189-192.

Golshan, M., Crapo, R.O., Amra, B., Jensen, R.I., & Golshan, R. (2007). Arm span as an independent predictor of pulmonary function parameters: validation and reference values. *Respirology*, 12(3), 361-366.

Hickson, M., & Frost, G. A (2003). comparison of three methods for estimating height in the acutely ill elderly population. *Journal of Human Nutrition and Dietitian*, 16(1), 13-20.

Ilayperuma, I., Nanayakkara, G., & Palahepitiya, N. (2010). A model for the estimation of personal stature from the length of forearm. *International Journal of Morphology*, 28(4), 1081-1086.

Jalzem, P.F., & Gledhill, R.B. (1993). Predicting height from arm span measurements. *Journal of Pediatric Orthopedics*, 13(6), 761-765.

Juresa, V., Musil, V., & Tiljak, M.K. (2012). Growth charts for Croatian school children and secular trends in past twenty years. *Collegium Antropologicum*, 36(s1), 47-57.

Kanchan, T., Menezes, R.G., Moudgil, R., Kaur, R., Kotian, M.S., & Garg, R.K. (2008). Stature estimation from foot dimensions. *Forensic Science International*, 179(2/3), 241e1-5.

Karadag, B., Ozturk, A.O., Sener, N., & Altuntas, Y. (2012). Use of knee height for the estimation of stature in elderly Turkish people and their relationship with cardiometabolic risk factors. *Archives of Gerontology and Geriatrics*, 54(1), 82-89.

Kaarma, H., Saluste, L., Lintsi, M., Kasmel, J., Veldre, G., Tiit, E.M., Koskel, S. & Arend, A. (2008). Height and weight norms for adult Estonian men and women (aged 20–70 years) and ways of somatotyping using a height-weight classification. *Papers on Anthropology*, XVII: 113–130.

Kułaga, Z., Litwin, M., Tkaczyk, M., Palczewska, I., Zajączkowska, M., Zwolińska, D., Krynicki, T., Wasilewska, A., Moczulska, A., Morawiec-Knysak, A., Barwicka, K., Grajda, A., Gurzkowska, B., Napieralska, E., & Pan, H. (2011). Polish 2010 growth references for school-aged children and adolescents. *European journal of pediatrics*, 170(5), 599-609.

Marfell-Jones, M., Olds, T., Stew, A.D., & Carter, J.E.L. (2006). *International standards for anthropometric assessment*. Potchesfstroom: International Society for the Advancement of Kinanthropometry.

Menezes, R.G., Kanchan, T., Kumar, G.P., Rao. P.P.J., Lobo, S.W., Uysal, S., Krishan, K., Kalthur, S.G., Nagesh, K.R., & Shettigar, S. (2009). Stature estimation from the length of the sternum in South Indian males: A preliminary study. *Journal of Forensic and Legal Medicine*, 16(8), 441-443.

Menezes, R.G., Nagesh, K.R., Monteiro, F.N.P., Kumar, G.P., Kanchan, T., Uysal, S., Rao, P.P.J., Rastogi, P., Lobo, S.W., & Kalthur, S.G. (2011). Estimation of stature from the length of the sternum in South Indian females. *Journal of Forensic and Legal Medicine*, 18(6), 242-245.

Milasinovic, R., Popovic, S., Jaksic, D., Vasilejvic, I. & Bjelica, D. (2016). Stature and its Estimation Utilizing Arm Span Measurements in Feale Adolescents from Southern Region in Montenegro. *Sport Mont*, 14(3), 15–18.

Milasinovic, R., Popovic, S., Matic, R., Gardasevic, J. & Bjelica, D. (2016). Stature and its Estimation Utilizing Arm Span Measurements in Male Adolescents from Southern Region in Montenegro. *Sport Mont*, 14(2), 21–23.

Mohanty, S.P., Babu, S.S., & Nair, N.S. (2001). The use of arm span as a predictor of height. A study of South Indian women. *Journal of Orthopedics Surgery*, 9(1), 19-23.

Nagesh, K.R., & Pradeep, K.G. (2006). Estimation of stature from vertebral column length in South Indians. *Legal Medicine*, 8(5), 269-272.

Penders, B., Brecheisen, R., Gerver, A., Van Zonneveld, G. & Gerver W.J. (2015). Validating Paediatric Morphometrics: body proportion measurement using photogrammetric anthropometry. *Journal of pediatric endocrinology and metabolism*, 28(11-12), 1357-1362.

Pineau, J.C., Delamarche, P. & Božinović, S. (2005). Average height of adolescents in the Dinaric Alps (in French). *Comptes Rendus Biologies*, 328(9), 841–846.

Popovic, S., Bjelica, D., Georgiev, G., Krivokapic, D. & Milasinovic, R. (2016). Stature and its Estimation Utilizing Arm Span Measurements in Macedonian Adults. *Anthropologist*, 24(3), 737-745.

Popović, S., Bjelica, D., & Hadžić, R. (2014). Average body height of adolescents in Montenegro. In *Proceedings book of the 13th International Sport Sciences Congress* (462-463). Konya: Selcuk University.

Popović, S., Bjelica, D., Molnar, S., Jakšić, D., & Akpinar, S. (2013). Body Height and Its Estimation Utilizing Arm Span Measurements in Serbian Adults. *International Journal of Morphology*, 31(1), 271-279.

Popovic, S., Bjelica, D., Tanase, G.D. & Milasinovic, R. (2015). Stature and Its Estimation Utilizing Arm Span Measurements in BH Adolescents. *Montenegrin Journal of Sports Science and Medicine*, 4(1), 29-36.

Quanjer, P.H., Capderou, A., Mazocioglu, M.M., Aggarwal, A., Popovic, S., Datta Banik, S., Tayie, F.A.K., Golshan, M., Ip, M.S.M., Zelter, M. (2014). All-age relationship between arm span and height in different ethnic groups. *European Respiratory Journal*, 44(4), 905-912.

Rao, P.P.J., Sowmya, J., Yoganarasimha, K., Menezes, R.G., Kanchan, T., & Aswinidutt, R. (2009). Estimation of stature from cranial sutures in a South Indian male population. *International journal of legal medicine*, 123(3), 271-276.

Rastogi, P., Nagesh, K.R., & Yoganarasimha, K. (2008). Estimation of stature from hand dimensions of north and south Indians. *Legal Medicine*, 10(4), 185-189.

Reeves, S.L., Varakamin, C., & Henry, C.J. (1996). The relationship between arm-span measurements and height with special reference to gender and ethnicity. *European Journal of Clinical Nutrition*, 50(6), 398-400.

Sahni, D., Sanjeev, Sharma, P., Harjeet, Kaur, G., & Aggarwal, A. (2010). Estimation of stature from facial measurements in northwest Indians. *Legal Medicine,* 12(1), 23–27.

Sanli, S.G., Kizilkanat, E.D., Boyan, N., Ozsahin, E.T., Bozkir, M.G., Soames, R., Erol, H., & Oguz, O. (2005). Stature estimation based on hand length and foot length. *Clinical Anatomy*, 18(8), 589-596.

Starc, G., & Strel, J. (2011). Is there a rationale for establishing Slovenian body mass index references of school-aged children and adolescents? *Anthropological Notebooks* 17(3), 89-100.

Statistics Denmark. *Denmark's Statistical Yearbook 2011*, 2011. Retrieved on March 5, 2012, from http://www.www.dst.dk/.

Statistics Netherland. Lifestyle, preventive screening; sex, age, 2015. Retrieved on March 15, 2016, from http://statline.cbs.nl/StatWeb/publication/?DM=SLEN&PA=81175ENG&D1=13-24&D2=1-2&D3=a&D4=0&D5=l&LA=EN&VW=T/.

Steele, M.F., & Chenier, T.C. (1990). Arm-span, height and age in black and white women. *Annals of Human Biology*, 17(6), 533-541.

Szöllősi, E. (1998). Secular trend in Debrecen university students (in Hungerian). *Anthropologiai Közlemények,* 39, 43-51.

Ter Goon, D., Toriola, A.T., Musa, D.I., & Akusu, S. (2011). The relationship between arm span and stature in Nigerian adults. *Kinesiology*, 43(1), 38-43.

TNO. *Lifelong Healthy and Active - PDF growth charts*, 2010. Retrieved on June 2, 2010, from http:// www.tno.nl/.

Tutkuviene, J. (2005). Sex and gender differences in secular trend of body size and frame indices of Lithuanians. *Anthropologischer anzeiger*, 63(1), 29-44.

Uhrova, P., Benus, R., Masnicova, S., Obertova, Z., Kramarova, D., Kyselicova, K., Dornhoferova, M., Bodorikova, S. & Nescakova, E. (2015). Estimation of stature using hand and foot dimensions in Slovak adults. *Legal medicine*, 17(2): 92-97.

Vignerová, J., Brabec, M., & Bláha, P. (2006). Two centuries of growth among Czech children and youth. *Economics and Human Biology*, 4(2), 237-252.

Vujovic, D., Bubanja, M., Tanase, G.D. & Milasinovic, R. (2015). Stature and Its Estimation Utilizing Arm Span Measurements in Male Adolescents from Central Region in Montenegro. *Sport Mont*, 12(43-45), 283-288.

Werner, B., & Bodin, L. (2006). Growth from birth to age 19 for children in Sweden born in 1981: descriptive values. *Acta Paediatrica*, 95(5), 600-613.

Wronka, I., & Pawliñska-Chmara, R. (2009). Childhood environment and adult height among Polish university students. *Collegium Antropologicum*, 33(4), 1039-1045.

Zverev, Y.P. (2003). Relationship between arm span and stature in Malawian adults. *Annals of Human Biology*, 30(6), 739-743.

ORIGINAL SCIENTIFIC PAPER

The Influence of the Number of Players on Workload during Small-Sided Games among Elite Futsal Players

Karel Hulka[1] and Radim Weisser[1]

Affiliations: [1]Palacký University Olomouc, Faculty of Physical Culture, Department of Sport, Olomouc Czech Republic

Correspondence: Karel Hulka, Palacký University Olomouc, Faculty of Physical Culture, Department of Sport, Hynaisova 9, 77900 Olomouc, Czech Republic. E-mail: karel.hulka@upol.cz

ABSTRACT Small-sided games are a specific form of training in which exercise intensity can be manipulated mainly by modifying external factors. The aim of this study was to determine the influence of a number of players during small sided futsal games on metabolic responses and distance covered at elite senior futsal players. Fifteen top level Czech futsal players (males, aged 26.81±5.30; body height = 176.10±4.34 cm; body weight = 71.31±5.30 kg, and peak heart rate=191.23±5.4 beats•min-1) participated in the study. Heart rate, blood lactate concentrations, distance covered, and rate of perceived exertion were monitored during small-sided futsal games. We found significant differences between blood lactate concentration values and perceived exertion; it was significantly higher during 3vs3 and 4vs4 small-sided games than during 6vs6 games. When we compared the distance covered by players, we found significantly higher distance covered during 4vs4 than in 6vs6 games. The results of this study demonstrated that the small-sided games 3vs3 and 4vs4 were valuable tools to develop specific futsal fitness. As the most intensive, the 4-a-side game was found.

KEY WORDS Heart Rate, Specificity, Distance Covered, Tactical Metabolic Training.

@MJSSMontenegro
WORKLOAD DURING SMALL-SIDED GAMES IN FUTSAL
http://mjssm.me/?sekcija=article&artid=130

Introduction

Futsal is the indoor version of soccer, and the organizing body remains FIFA (Barbero-Alvarez, Soto, Barbero-Alvarez, V., & Granda-Vera, 2008). Futsal is played between two teams of four field players and one goalkeeper player, on a 40 × 20 m pitch with 3 × 2 m goals. The match lasts two equal periods of 20 minutes, but, like basketball, the clock is stopped for some events (Barbero-Alvarez, D'Ottavio, Granda Vera, & Castagna, 2009).

Futsal is a game of intermittent high intensity and sizeable distances covered during match play (Bangsbo, Mohr, & Krustrup, 2006; McMillan, Helgerud, Macdonald, & Hoff, 2005). The futsal match is 70-80 min long; the players make approximately 6 to 8 alternations. Distances covered at the top level ranged from 2575 to 4313 m (Dogramaci, Watsford, & Murphy, 2011; Barbero-Alvarez et al., 2008). Mean heart rate moves from 174 to 176 beats per minute and 83-87 % of the game time is spent over 85% of peak heart rate (Barbero-Alvarez et al., 2008; Tessitore et al., 2008). Because of the game duration, soccer is mainly dependent upon aerobic metabolism (Stolen, Chamari, Castagna, & Wisloff, 2005), which is why specific aerobic conditioning is needed (Stone & Kilding, 2009).

Small-sided games (SSG) have been extensively studied as they are very popular as a conditioning tool in amateur and elite football (Randers, Nielsen, Bangsbo & Krustrup, 2014). Small-sided games became a popular method of developing soccer specific aerobic fitness (Impellizzeri et al., 2006). The high specificity of loading, decision making under pressure of opponents, and keeping players motivated were the most significant advantages of using SSG in soccer training (Reilly, 2005). The researchers have examined variables that may affect the intensity of SSG in all games (soccer, handball, basketball, etc.) such as dimensions of the pitch number of players, rule modifications, continuous and intermittent modality, goalkeepers' participation, and coach encouragement (da Silva et al., 2011; Hill-Haas, Coutts, Rowsell, & Dawson, 2008; Hulka, Weisser,

Accepted after revision: October 08 2016 | First published online: March 01 2017

Conflict of interest: None declared.

& Belka, 2016; Rampinini et al., 2007; Impellizzeri et al., 2006). The aim of this study was to determine the influence of the number of players during small-sided futsal games on metabolic responses and distance covered among elite senior futsal players.

Methods

Participants

The research study involved a total of 15 top level Czech futsal players (males, age 26.81±5.30 years; body height =176.10±4.34 cm; body weight =71.31±5.30 kg, and peak heart rate=191.23±5.4 beats·min-1) who played in the highest nationwide Chance Futsal League in 2014/15, Futsal Champions League, and UEFA Futsal Cup. Players were in four team sessions per week. Therefore, the players in our sample had several years of experience. Prior to data collection, the players were informed about the purpose of the measurement, signed the informed consent related to Helsinki declaration, and the results were provided to the players on an individual basis. The involvement of the players was voluntary, and the results were used only for the study.

Procedures

To analyse the internal response to players' load during measured small-sided games, we applied heart rate monitoring during the measurement using the TEAM Polar2Pro system (Polar Electro, Kempele, Finland). We expressed the measured data as a percentage of HRpeak (Capranica, Tessitore & Guidetti, 2001; Hulka, Cuberek & Belka, 2013) and we used six HRpeak zones (as described below) according to Barbero-Alvarez et al. (2008), and Duarte, Batalha, Folgado and Sampaio (2009) because of the possibility of better comparing our gained data with other studies. Mentioned authors defined HRpeak zones conception as follows: < 65% HRpeak, 65% ≤ HR ≤ 85% HRpeak, > 85% HRpeak.

Blood lactate concentration was measured by Lactate Scout+ before and after every small-sided game. RPE was assessed with the 15-point Borg scale (Borg, 1998) after finishing every small-sided game and friendly basketball match.

The SSG were recorded with two Canon HF10 video cameras (each with a resolution of 1280×720 pixels). Each camera was used to record a separate half of the court (20×20 m) according to Hulka, Cuberek & Svoboda (2014). Video records were analysed per a standardized procedure using a software package (Video Manual Motion Tracker 1.0, Faculty of Physical Culture, Palacky University Olomouc, Czech Republic). This method enables the recording of the total distance covered during a match. Additionally, it allows for measurement of the immediate and average velocity of the players during a match or training. Next, the intensity profile of player's performance was grouped, according to Barbero-Alvarez J., Soto, Barbero-Alvarez, V. and Granda-Vera (2008) and Bishop and Wright (2006), to movements performed by low intensity activity executed with velocity 0 to 3.00 m·s-1, and included inactivity to 0.10 m·s-1, walking from 0.10 to 1.00 m·s-1, and jogging from 1.10 to 3.00 m·s-1. The movements performed by medium intensity activities executed with velocity from 3.10 to 5.00 m·s-1 were generated by the second group, and the maximal intensity activity with the velocity over 5.10 m·s-1 was generated by the last group.

All measurements were on a 20×40 m indoor court. Two weeks before the measurement, the participants took a maximum load field test "Yo-Yo intermittent level 1 recovery test" (Bangsbo, Iaia, & Krustrup, 2008) to determine peak heart rate (HRpeak). The measurement took place every Tuesday after the Monday regeneration session. For every measured session, only one type of SSG was applied in three repetitions. The time of work was 4 minutes, and we used a four-minute recovery according to Casamichana and Castellano (2010), and Duarte, Batalha, Folgado, and Sampaio (2009). We tracked the changes during SSG with different numbers of players (3vs3, 4vs4, 5vs5, and 6vs6). Every measured session was started by warm-up twenty minutes long, which consisted of five minutes of passing and shooting drill (jogging tempo), ten minutes of dynamic whole body stretches, and brief high-intensity runs with the ball.

Statistical data analysis

For statistical data processing, we used the SPSS statistical software (17.0 version; SPSS Inc., Chicago, IL). Because of small sample size, a non-parametric Kruskal-Wallis test and post hoc Dunn's nonparametric comparison were used. The level of significance was determined at an alpha level of $p<0.05$.

Results

The distance covered and appropriate metabolic responses of players during the observed small-sided games are shown in Table 1. Metabolic response was expressed by mean heart rate, the percentage of peak heart rate, blood lactate concentration after work, and Borg scale.

We found significant differences between blood lactate concentration values ($H=9.21$; $p=0.041$), where it was significantly higher during 3vs3 ($r=0.001$) and 4vs4 SSG ($r=0.004$) than during 6vs6 SSG. Similarly, we found perceived exertion of players during SSG ($H=11.21$; $p=0.004$), because perceived exertion during 4vs4 ($r=0.005$) was higher than during 6vs6.

When we compared the distance covered by the players, we found significantly higher distance covered during 4vs4 than 6vs6 ($H=9.05$; $p=0.044$; $r=0.43$).

UDC 796.33:612.015.3

TABLE 1 Results of distance covered and metabolic response of players during observed small-sided games

	3vs3	4vs4	5vs5	6vs6
HR_{mean} (beats·min^{-1})	161.46±8.97	164.20±6.92	158.67±7.16	156.27±7.87
% HR_{peak} (%)	84.44±4.69	85.17±3.01	83.05±3.74	82.24±4.12
BLa (mmol·L^{-1})	7.76 ± 1.09*	7.25 ± 0.76*	5.53 ± 0.97	3.91 ± 0.71
Borg scale	14.25 ± 1.41	15.55±2.02*	13.25 ± 1.45	12.21 ± 1.63
Distance (m)	1732.91 ± 161.89	1776.08 ± 154.27*	1678.77 ± 173.38	1566.25 ± 151.21

Legend: * - statistical significant differences on level of P< 0.05

Discussion

Small-sided games are a suitable instrument for football specific aerobic conditioning development (Little, 2009). To prevent the players from undertraining or overtraining, it is vital to know variables, which can influence the exertion of players during Small-sided games (Dellal, Hill-Haas, Lago-Penas, & Chamari, 2011). In this study, we wanted to determine the influence of the number of players on the exertion of players and their metabolic response. Measured SSG caused relatively lower metabolic response than futsal matched did (Barbero-Alvarez J. et al., 2008). However, According to Hoff, Wisloff, Engen, Kemi and Helgerud (2002) the values of 3vs3 and 4vs4 were considered to be a significant stimulus to the cardiovascular system. SSG 6vs6 and 5vs5 were not found to be a suitable instrument for-futsal specific aerobic conditioning development. Appropriate use of small-sided games is the way to work in the team with individualized training load, in which the endurance training, technical, and tactical training are connected (Hulka, Weisser, Belka & Hap, 2015).

Casamichana and Castellano (2010) found that the effective playing time could offer a potential explanation for the differences in the metabolic demands. As the individual playing area was reduced by the increased number of players, the frequency of motor behaviour increased, with a concomitant decrease in effective playing time. At the same time, the players covered less distance, spend more time stationary or walking, which leads to a lower physiological workload and lower ratings of perceived exertion during 6vs6 and 5vs5 (Aguiar, Botelho, Lago, Maças, & Sampaio, 2012). Moreover, with increased number of players, the tactical and technical demands of players grow.

According to our results, the most intensive SSG was 4vs4, not 3vs3 as expected. This fact can be explained by different tactical conception, based on positional plays. The size of exertion was able to be influenced by subconscious saving the energy because of the small number of players. The application of 3vs3 or 4vs4 SSG to the training session generated very similar exertion and metabolic responses of players. Thus, decreasing the number of players with the purpose of increasing exertion is useless.

We have found the differences in metabolic response measurement. While the measurement of heart rate showed no differences among SSG, the blood lactate concentration perceived exertion measurement showed the differences. We showed that heart rate was similar tendencies but not as sensitive as the other ones. It can be explained by different structures of intermittent performance. During 6vs6 and 5vs5, more recovery time was needed for lactate disposal.

Conclusion

The results of this study demonstrated that the small sided games 3vs3 and 4vs4 were valuable tools to develop specific futsal fitness. Appropriate use of small-sided games is the way to work in the team with individualized training load, where the endurance training, technical, and tactical training are connected. The 4-a-side game was found to be the most intensive .

REFERENCES

Aguiar, M., Botelho, G., Lago, C., Maças, V., & Sampaio, J. (2012). A Review on the effects of soccer small-sided games. *Journal of Human Kinetics,* 33, 103-113.

Bangsbo, J., Iaia, F. M., & Krustrup, P. (2008). The Yo-Yo intermittent recovery test: A useful tool for evaluation of physical performance in intermittent sports. *Sports Medicine,* 38, 37–51.

Bangsbo, J., Mohr, M., & Krustrup, P. (2006). Physical and metabolic demands of training and match-play in the elite soccer player. *Journal of Sports Sciences,* 24, 665–674.

Barbero-Alvarez, J. C., D'Ottavio, S., Granda Vera, J., & Castagna, C. (2009). Aerobic fitness in futsal players of different competitive level. *Journal of Strength and Conditioning Research,* 23(7), 2163–2166.

Barbero-Alvarez, J. C., Soto, V. M., Barbero-Alvarez, V., & Granda-Vera, J. (2008). Match analysis and heart rate of futsal players during competition. *Journal of Sports Sciences*, 26(1), 63–73.

Bishop, D. C., Wright, C. A. (2006). Time-motion analysis of professional basketball to determine the relationship between three activity profiles: high, medium and low intensity and the length of the time spent on court. *International Journal of Performance Analysis in Sport,* 6(1), 130-138.

Castellano, J., & Casamichana, D. (2010). Heart rate and motion analysis by GPS in beach soccer. *Journal of Sports Science and Medicine 9,* 98-103.

Da Silva, C. D., Impellizzeri, F. M., Natali, A. J., de Lima, J. R. P., Bara, M. G., Silami-Garcia, E., & Marins, J. C. B. (2011). Exercise intensity and technical demands of small-sided games in young Brazilian soccer players: effect of number of players, maturation, and reliability. *Journal of Strength and Conditioning Research,* 25(10), 2746–2751

Dellal, A., Hill-Haas, S., Lago-Penas, C., & Chamari, K. (2011). Small-sided games in soccer: amateur vs. professional players' physiological responses, physical, and technical activities. *Journal of Strength and Conditioning Research,* 25(9), 2371-2381.

Dogramaci, S. N., Watsford, M. L., & Murphy, A. J. (2011). Time-Motion Analysis of International and National Level Futsal. *Journal of Strength and Conditioning Research.* 25(3), 646-665.

Duarte, R., Batalha, N., Folgado, H. and Sampaio, J. (2009). Effects of Exercise Duration and Number of Players in Heart Rate Responses and Technical Skills During Futsal Small-Sided Games. *The Open Sports Sciences Journal,* 2.

Hill-Haas, S., Coutts, A., Rowsell, G., & Dawson, B. (2008). Variability of acute physiological responses and performance profiles of youth soccer players in small-sided games. *Journal of Science and Medicine in Sport,* 11, 487–490.

Hoff, J., Wisloff, U., Engen, L. C., Kemi, O. J., & Helgerud, J. (2002). Soccer specific aerobic endurance training. *British Journal of Sports Medicine,* 36(3), 218-221.

Hulka, K., Cuberek, R., & Belka, J. (2013). Heart rate and time-motion analysis in top junior players during basketball matches. *Acta Universatis Palackienae Olomoucensis. Gymnica,* 43(3), 27-35.

Hulka, K., Cuberek, R., & Svoboda, Z. (2014). Time-motion analysis of basketball players: A reliability assessment of Video Manual Motion Tracker 1.0 software. *Journal of Sports Sciences,* 32, 53–59.

Hulka, K., Weisser, R., & Belka, J. (2016). Effect of the pitch size and presence of goalkeepers on the work load of players during small-sided soccer games. *Journal of Human Kinetics,* 51, 131-141.

Hulka, K., Weisser, R., Belka, J., & Hap, P. (2016). The influence of different level of opponents on internal responses and external loads during small-sided games in soccer. *Acta Gymnica,* 45(3), 113–119.

Impellizzeri, F. M., Marcora, S. M., Castagna, C., Reilly, T., Sassi, A., Iaia, F. M., & Rampinini, E. (2006). Physiological and performance effects of generic versus specific aerobic training in soccer players. *International Journal of Sports Medicine,* 27, 483–492.

Little, T. (2009). Optimizing the use of soccer drills for physiological development. *Strength and Conditioning Journal,* 31(3), 67-74.

McMillan, K., Helgerud, J., Macdonald, R., & Hoff, J. (2005). Physiological adaptations to soccer specific endurance training in professional youth soccer players. *British Journal of Sports Medicine,* 39, 273–277.

Rampinini, E., Impellizzeri, F. M., Castagna, C., Abt, G., Chamari, K., Sassi, A., & Marcora, S. M. (2007). Factors influencing physiological responses to small-sided soccer games. *Journal of Sports Sciences,* 25, 659–666.

Randers, M. B., Nielsen, J. J., Bangsbo, J., & Krustrup, P. (2014). Physiological response and activity profile in recreational small-sided football: No effect of the number of players. *Scandinavian Journal of Medicine & Science in Sports* 24, 130-137.

Reilly, T. (2005). An ergonomics model of the soccer training process. *Journal of Sports Sciences,* 23, 561–572.

Stolen, T., Chamari, K., Castagna, C., & Wisloff, U. (2005). Physiology of soccer: An update. *Sports Medicine,* 35, 501–536.

Stone, N. M., & Kilding, A. E. (2009). Aerobic conditioning for team sport athletes. *Sports Medicine,* 39, 615–642.

Tessittore, A., Meeusen, R.,Pagano, R.,Benvenuti, C., Tiberi, M., & Capranica, L. (2008). Effectives of Active versus Passive Recovery Strategies after Futsal Games. *Journal of Strength and Conditioning Research,* 22(5), 1402-1412.

UDC 796.33:612.015.3

ORIGINAL SCIENTIFIC PAPER

Comparison of Standard and Newer Balance Tests in Recreational Alpine Skiers and Ski Novices

Vjekoslav Cigrovski[1], Ivica Franjko[1], Tomislav Rupčić[1], Marijo Baković[1] and Andro Matković[2]

Affiliations: [1]University of Zagreb, Faculty of Kinesiology, Zagreb, Croatia, [2]Clinical Hospital Merkur, Clinical Department for Diagnostic and Interventional Radiology, Zagreb, Croatia

Correspondence: Vjekoslav Cigrovski, University of Zagreb, Faculty of Kinesiology, Horvaćanski zavoj 15, 10000 Zagreb, Croatia. E-mail: vcigrov@kif.hr

ABSTRACT Alpine skiers should physically prepare for skiing due to the specific body movements it requires. As balance is essential for the success of competitive alpine skiers, we investigated its importance during preparation for alpine skiing in recreational skiers. We included 24 male participants; twelve recreational skiers just after 10 days of alpine skiing, and twelve alpine ski novices. All participants were tested with two balance tests (BAL40 and GYKO). Participants of the two groups did not differ significantly in the results of the BAL40 standard balance test. In contrast, we found significant differences in four out of six variables measured with the GYKO test performed on BOSU trainer during the two-feet stand. Participants specifically differed in the variables overall average body tilt (p=0.02), overall average deviation of body tilt (p=0.00), overall medio-lateral average body tilt (p=0.01), and overall medio-lateral average deviation of body tilt (0.00). Average results were lower for participants of the group of recreational skiers than for participants of the novice alpine ski group, suggesting that balance is important for recreational skiers, either as an acquired trait during skiing, or the result of conditioning training in the preparation period for skiing. According to the results, we would advise recreational skiers as well as people planning to be involved in alpine skiing as a new recreational activity to include balance exercises in the preparation period.

KEY WORDS Recreational Level Alpine Skiers, Motor Abilities, Conditioning Training.

@MJSSMontenegro
BALANCE DIFFERENCES BETWEEN SKIERS AND NON-SKIERS
http://mjssm.me/?sekcija=article&artid=131

Introduction

Due to specific movements, alpine skiing imposes high requirements concerning physical fitness, particularly regarding muscle strength and balance abilities (Ferguson, 2010). It is a sport with predominant eccentric muscle contraction (Berg & Eiken, 1999; Hoppeler & Vogt, 2009), which is specific muscle activity for slowing down in every-day life, for example, while walking downhill. Hoppeler and Vogt (2009) investigated the concept of eccentric-contraction-based conditioning training in professional alpine skiers. In that study, a bicycle ergometer specially designed to produce eccentric movements was used for the training of junior alpine ski competitors. The study showed that the dosing of eccentric contractions has a beneficial effect on maximal speed during a competitive race in alpine skiing. In line with this, it is generally accepted that competitive level skiers develop and train those abilities, which are crucial for success in specific disciplines of alpine skiing.

In contrast, alpine skiing is also one of the most popular winter leisure activities, with millions of people participating at the recreational level. The popularity has become even more apparent since the introduction of carving skis with more sidecut, and these changes have resulted in greater requirements of physical fitness including a sense of balance from recreational skiers (Müller & Schwameder, 2003; Cigrovski, Božić, Prlenda, 2012; Rachner et al., 2012). Many studies have shown that the development of specific motor abilities and muscle strength has a beneficial effect on the safe and effective learning of alpine skiing (Hébert-Losier & Holmberg,

Accepted after revision: October 08 2016 | First published online: March 01 2017

Conflict of interest: None declared.

2013). As preparation for alpine skiing can be time-consuming (usually should start few months before actual skiing), people often choose not to engage in training. To increase an individual's skiing performance and reduce the skiing injuries, greater attention should be paid to the fitness level (Turnbull et al., 2009; Raschner et al., 2012) and physical preparedness for alpine skiing. Therefore, the idea is to offer recreational skiers specialized and directed programs of shorter duration targeting muscles involved in alpine skiing, instead of the gym, running or bicycling. In the preparation period for recreational alpine skiing, depending on the person's lifestyle, exercises for eccentric muscle contraction should be included.

In addition, it is also prudent to include exercises for balance, which is key for maintaining stable positions on skis (Wojtyczek, Pasławska, Raschner, 2014), although, interestingly, literature on balance parameters during skiing is rare (Hebert-Losier et al., 2014). Specifically, one of the prerequisites for optimal ski turn is maintaining central balance position on skies throughout all turn phases (Loland, 2009); of secondary importance is the positioning of the skies on the side edges and leading the skies in desired direction. If this is not fulfilled, skies will probably skid, and the skier will lose control over the speed of skiing and the central balance position (Spörri et al. 2012; Cigrovski & Matković, 2015). Hrysomallis (2007) reported poor balance skills were significantly associated with an increased risk of injuries, but Staniszewski and colleagues (2016) showed that skiing has a positive effect on postural stability regardless of the skier's level of technical skills. There are many tests to evaluate balance, but not all are sufficiently discriminative to identify people with low performance and facilitate intervention programs to develop/improve specific balance skills for alpine skiing. Moreover, there is still insufficient evidence from controlled trials on the relationship between laboratory balance tests, field balance tests, and the acquisition of alpine ski knowledge/skiing performance. Therefore, the purpose of the present study was to evaluate the balance performance on two balance tests-standard balance board test BAL40 and newer GYKO test in order to find the best one to evaluate balance performance of skiers and non-skiers in order to help improve balance during preparation for skiing.

Methods

Participants

We included 24 participants, all male students of the School of Kinesiology, University of Zagreb. Their average age was 23.8±1.78 years. Participants were divided into two different groups; one group included recreational skiers, who participated in alpine skiing for at least 10 days per year, and other group included participants that had never been involved in alpine skiing (alpine ski novice). This grouping was done according to participants' self-evaluation. Participants were preselected according to their motor abilities during the selection process of enrolment to the School of Kinesiology and did not differ significantly in general motor abilities, i.e. they were a homogenous group according to motor abilities. This study was approved by Ethics Committee of the School of Kinesiology, University of Zagreb. Each participant voluntarily provided written informed consent before participating and was thoroughly informed about study aims and procedures.

Variables

All included participants were tested on two different balance tests assessing balance. The newly selected test for the evaluation of balance was performed on a BOSU balance trainer with a GYKO instrument attached to participants' backs (GYKO test), while a standard test evaluating balance (BAL40) was performed on a balance board during two-feet jumps. Tests were performed during the 2015 winter season after recreational skiers

FIGURE 1 Participant during GYKO testing at BOSU balance trainer

had completed 10 days of alpine skiing. For all participants, tests were conducted in the same measurement conditions and at the same time of day.

The GYKO test is performed on a BOSU balance trainer, which simulates the unstable conditions encountered during alpine skiing. The participant is asked to stand barefoot for 30 seconds in the central balance position on a BOSU balance trainer with a GYKO instrument attached to the thoracic part of the back. The GYKO is a specifically designed measurement tool for the analysis of movement, with a Bluetooth data transmission option providing real-time measurement data transfer to a PC via the Microgate software which is a validated program for data processing and interpretation. GYKO makes it possible to objectively evaluate and monitor the stability and balance of a standing subject. It provides information on various components of the postural system, such as visual, proprioceptive, labyrinthine, etc., through indexes such as sway frequency, projection travel speed, and projection length area. In this research, we specifically measured the following: overall average body tilt (Length), overall average deviation of body tilt (Mean length dev), overall medio-lateral average body tilt (Ml length), overall medio-lateral average deviation of body tilt (Ml length dev), overall antero-posterior average body tilt (Ap length), overall antero-posterior average deviation of body tilt (Ap length dev). Measurements were done in mm.

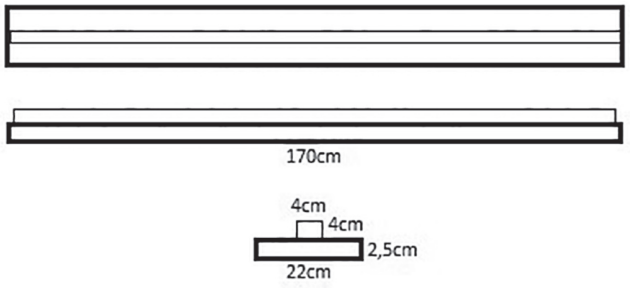


FIGURE 2 Construction characteristics of instrument for BAL40 test

The BAL40 test is performed on a measuring instrument 170.0 cm in length and 22.0 cm high. The height of the basic edge was 2.5 cm, with the height and width of the elevation being 4 cm. The upper elevation was marked with a line which divided it into two equal parts. Participants placed both feet on the elevation on one side of the line. Then they arbitrarily performed two-feet jumps while skipping over the marked line that divided the elevation into two symmetrical parts. Participants had to perform as many correct two-feet jumps as possible. The total number of performed two feet jumps was recorded and the task was repeated three times. The final result represented the best achieved result. An attempt was considered to be invalid if the participant touched the lower surface of the measuring instrument or the line in the middle of the measuring instrument with any part of the foot during test performance.

Statistical Analysis

Data was processed with Statistica statistical program (ver.12). Basic descriptive parameters were calculated for tests evaluating balance. Differences between participants of the two groups (group one (recreational alpine skiers) and group two (alpine ski novice participants)) in the results of tests assessing balance were detected by t-test. Results were significant at $p<0.05$.

Results

In Tables 1 and 2, basic descriptive parameters are given for two groups of participants in the BAL40 test and six variables obtained in the GYKO test.

TABLE 1 Basic Descriptive Parameters of BAL40 and GYKO Test Results for Alpine Ski Naive Participants (n=12)

Variable	M	Min	Max	SD
Bal40	3.96	2.33	5.00	0.82
Gyko-length	222.41	121.1	319.10	67.30
Gyko- mean length dev	2.94	1.87	4.53	0.86
Gyko-ml length	139.09	61.37	192.73	43.86
Gyko-ml length dev	16.00	9.93	24.53	4.99
Gyko-ap length	141.62	79.87	222.53	49.18
Gyko-ap length dev	4.31	1.55	8.70	2.21

Legend: Bal40 – balance evaluation test; Gyko-length – overall average body tilt on BOSU trainer during two-feet stand; Gyko-mean length dev – overall average deviation of body tilt on BOSU trainer during two-feet stand; Gyko-ml length – overall medio-lateral average body tilt on BOSU trainer during two-feet stand; Gyko-ml length dev – overall medio-lateral average deviation of body tilt on BOSU trainer during two-feet stand; Gyko-ap length – overall antero-posterior average body tilt on BOSU trainer during two-feet stand; Gyko-ap length dev – overall antero-posterior average deviation of body tilt on BOSU trainer during two-feet stand

In an additional analysis, a t-test was used to determine differences in balance between the two groups of participants.

TABLE 2 Basic Descriptive Parameters of BAL40 and GYKO Test Results for Recreational Alpine Skiers (n=12)

Variable	M	Min	Max	SD
Bal40	3.86	3.33	4.66	0.48
Gyko-length	163.77	125.33	244.87	34.67
Gyko- mean length dev	1.94	1.17	2.90	0.55
Gyko-ml length	97.05	73.27	140.90	22.65
Gyko-ml length dev	10.02	4.93	17.53	4.34
Gyko-ap length	110.22	86.1	168.97	24.80
Gyko-ap length dev	2.71	1.43	5.83	1.27

The study did not show any significant differences related to the BAL40 test between recreational skiers and novice alpine ski participants (Table 3). In contrast, analysis of results in the GYKO test shows statistically significant differences between the participants pertaining to the group of recreational alpine skiers compared to the group of novice alpine ski participants in four variables. Recreational alpine skiers differed from novice alpine ski participants in results in overall average body tilt (p=0.02), overall average deviation of body tilt (p=0.00), overall medio-lateral average body tilt (p=0.01), overall medio-lateral average deviation of body tilt (0.00). After 10 days of alpine skiing, recreational skiers had fewer deviations and body tilts when measured with the GYKO on an unstable surface such as BOSU balance trainer, indicating a higher level of balance.

TABLE 3 T-test Results for Alpine Ski Naive Participants (0) and Recreational Skiers (1)

Variable	M	M	SD	SD	t	p
Skiers=1; Alpine ski naïve participants=0	0	1	0	1		
Bal40	3.96	3.862	0.82	0.47	0.36	0.74
Gyko-length	222.41	163.74	67.30	34.67	2.45	0.02*
Gyko- mean length dev	2.94	1.93	0.86	0.55	3.10	0.00*
Gyko-ml length	139.09	97.05	43.86	22.65	2.69	0.01*
Gyko-ml length dev	16.00	10.02	4.99	4.34	2.86	0.01*
Gyko-ap length	141.62	110.22	49.18	24.80	1.80	0.09
Gyko-ap length dev	4.31	2.71	2.21	1.27	1.98	0.06

Legend: * p<0.05

Discussion

Among competitive skiers physical training is mainly directed to the improvement of performance, while in recreational alpine skiers it is intended to prevent injury and improve the learning of alpine ski basics, making it safe and enjoyable. Moreover, while competitive skiers invest significant amounts of time for physical training, recreational skiers often find it time consuming and avoid partaking in physical preparation training Several prominent orthopedic authorities have advocated conditioning to reduce the risk of skiing injuries (Senner et al., 2009), but there is still no solid data indicating which program and what exercises would be of importance. It seems prudent to include exercises involving the muscles and joints that do the workload during alpine skiing, and specifically train/improve motor abilities such as lower body strength, power and balance (Cigrovski, Prlenda, Radman, 2014; LeMaster, 2009).

The investigation of young students of physical education showed that motor abilities correlate with the success of acquiring ski knowledge, especially during beginning phases (Aerenhouts et al., 2013). Moreover, better prepared recreational alpine skiers will have lower injury risk during learning and improving ski technique. Balance is a major component of performance in skiing, and different studies confirmed that loss of balance was the main reason for sustaining a skiing injury (Laskowski, 1997; Natri et al., 1999). In contrast, studies suggest that level of expertise in alpine skiing correlates with balance and that skiing can improve one's balance abilities (Wojtyczek et al., 2014). An investigation by Staniszewski and colleagues (2016) showed that training program affects forward/backward and sideways body sways in ski beginners, which works in a positive way for the function of maintaining balance in skiing. In line with this, our investigation aimed to determine the importance of motor ability balance for recreational alpine skiing as well as the value of different tests used for balance assessment.

UDC 796.926:796.2

The investigation of postural control performed by Noe and Paillard (2005) on competitive level alpine skiers (national and regional level competitors) showed its importance in ankle injury prevention. Professional skiers obtained significantly better balance values while wearing ski boots, suggesting the ski-specific impact on balancing habits (Noe and Paillard, 2005). Moreover, Mildner, Lembert, and Raschner (2010) suggest that in addition to general conditioning, skiers should utilize general and ski-specific balance and sensomotor training, which could help in knee injury prevention.

We used tests to evaluate both static and dynamic balance in young capable male students of the School of Kinesiology, divided into two groups differing mainly in their involvement in recreational level alpine skiing. One group included recreational alpine skiers after 10 days of an alpine ski program, and the other group included alpine ski novices, with no experience in alpine skiing. Due to the importance of balance and achieving and maintaining a stable position on skis (Noe et al., 2009), we attempted to define specific exercises that can influence better preparedness for alpine skiing at the recreational level. As there are over 200 million people worldwide practicing recreational skiing, it is important to find specific exercises that would aid in injury prevention (Hunter, 1999). Programs that are usually offered to people are comprehensive and last a few months (Thiel et al., 2009). Their main flaw is that only a small number of people participate and continue this practicies. In the case of non-adherence, recreational alpine skiers regardless of the improvements in equipment for alpine skiing risk the possibility of injury (Cigrovski & Matković, 2015). Modern ski carving techniques require a strong sense of balance while edging with skies.

Moreover, stiff ski boots increase the difficulty of balancing (Mildner, Lembert, and Raschner, 2010). Those are the reasons that current trends in conditioning training lead to intensive programs with efforts to detect people with lower level of specific motor abilities that will improve them and thus prevent injuries, which are otherwise inevitable (Burtscher et al., 2009; Senner et al., 2009). According to research, more than 90% of all injuries are due to falling, i.e. losing balance, and can to a great extent be prevented by adequate physical preparedness (Burtscher et al., 2009; Tchórzewski et al., 2013; Philippe et al., 2014).

Interestingly, publications on issues related to balance parameters during skiing are relatively rare in alpine ski literature (Hebert-Losier et al., 2014). Available data suggest different tests to evaluate balance; some more useful than others from the aspect of testing practicality in recreational skiers (Ružić et al., 2008). For competitive skiers, Nourrit and coworkers (2003) suggest the use of specific ski-stimulators which help to develop dynamic balance and at the same time use muscle contractions characteristic for alpine skiing. In our previous research, we tested the usefulness of different laboratory balance tests and found a correlation between levels of balance recorded on plywood balance board with newly acquired ski knowledge in ski beginners. Our results suggest that participants doing better on balance tests achieve better results in learning alpine ski technique and vice versa (Cigrovski et al., 2009). Similarly, Ružić and colleagues tested the power of balance board as a surrogate test for "on-the-skis" balance (Ružić et al., 2008). Available balance tests differ greatly not just in their commercial availability but also in a safe and easy way of testing. These were the main reasons why in this study we used specific balance tests in the context of recreational level alpine skiers. The BOSU balance trainer is a useful tool for evaluating balance. It is easily accessible and very usable for mimicking conditions of "on-the-skis" balance. GYKO, in contrast, represents the tool to measure and objectify the balance skill of a subject. When attached to the trunk it provides information about the body sway of the subject and it enables evaluating the relative contribution made by the various components of the postural system by giving information on projection length and area, projection travel speed, and sway frequency. GYKO is mainly used as a helping tool monitoring success of physical therapy after injury or orthopedic operation, and to the best of our knowledge there are no literature data on its use in testing the balance of recreational alpine skiers, so in this sense our data pioneers its use in monitoring present balance skills before skiing or the development of specific balance skills after the alpine ski program.

Our research posits balance to be a major feature that needs to be incorporated in the conditioning training of people planning to participate in alpine skiing. According to our results, the balance was more pronounced in the group of recreational level skiers, perhaps as a result of specific muscle coordination and postural control exerted by alpine skiing. Similarly, a study by Zemkova (2014) showed that skiers were more stable than non-skiers while standing in ski boots. Balance training on a BOSU trainer is advisable because it offers the possibility to train static balance i.e. maintaining a stable position on the unstable surface. Analysing our results, we would suggest trainers and alpine ski instructors to design the conditioning training of recreational level skiers in a specific and focused way. By using specific exercises on a BOSU trainer, they will mimic conditions and muscle work specific for alpine skiing, and directly influence the development of those motor abilities that are crucial for learning and perfecting/mastering alpine skiing. This should also help to minimize ski injuries and lead to effective ski learning.

Acknowledgements

The authors are grateful to HEP (national electricity company) for supporting our measurements as well as to Microgate and the Faculty of Kinesiology, the University of Zagreb for their contribution to this research.

REFERENCES

Aerenhouts, D., Raedemaeker, L., Clarys P. & Zinzen, E. (2013). Energy expenditure in novice skiers and snowboarders. In *E. Müller, J. Kroll, S. Lindiger (Eds.), Science and Skiing VI* (pg. 89-94). Maidenhead: Meyer & Meyer Sport (UK) Ltd.

Berg, H.E. & Eiken, O. (1999). Muscle control in elite alpine skiing. *Medicine & Science in Sports & Exercise*, 31(7), 1065-1067.

Burtscher, M., Puhringer, R., Werner, I., Sommersacher, R. & Nachbauer, W. (2009). Predictors of falls in downhill skiing and snowboarding. In E. Müller, S. Lindinger, T. Stöggl (Eds.), *Science and Skiing IV* (pg. 183-187). Maidenhead: Meyer & Meyer Sport (UK) Ltd.

Cigrovski, V., Matković, B. & Prlenda, N. (2009). Povezanost ravnoteže s procesom usvajanja skijaških znanja. *Hrvatski športskomedicinski vjesnik*, 24(1), 25-29.

Cigrovski, V., Božić, I. & Prlenda, N. (2012). The influence of motor abilities on learning of alpine ski technique. *SportLogia,* 8(2), 188-201.

Cigrovski, V., Prlenda, N. & Radman, I. (2014). Future of alpine skiing schools-gender related programs. *Montenegrin Journal of Sports Science and Medicine*, 3(1), 5-8.

Cigrovski, V. & Matković, B. (2015). *Skijaška tehnika-carving*. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.

Ferguson, R.A. (2010). Limitations to performance during alpine skiing. *Experimental Physiology*, 95(3), 404-410.

Hébert-Losier, K. & Holmberg, H.C. (2013). What are the exercise-based injury prevention recommendations for recreational alpine skiing and snowboarding? A systematic review. *Sports Medicine*, 43(5), 355-366.

Hébert-Losier, K., Supej, M. & Holmberg, H. (2014). Biomechanical factors influencing the performance of elite alpine ski racers. *Sports Medicine*, 44(4), 519-533.

Hoppeler, H. & Vogt, M. (2009). Eccentric exercise in alpine skiing. In *E. Müller, S. Lindinger, T. Stöggl (Eds.), Science and Skiing IV* (pg. 33-42). Maidenhead: Meyer & Meyer Sport (UK) Ltd.

Hunter, R.E. Skiing injuries. (1999). *American Journal of Sports Medicine*, 27, 381-389.

Hrysomallis, C. (2007). Relationship between balance ability, training and sports injury risk. *Sports Medicine*, 37(6), 547-556.

Laskowski, E.R., Newcommer-Aney, K & Smith. J. (1997). Refining rehabilitation with proprioception training: expediting return to play. *The Physician and Sportsmedicine*, 25, 89-102.

LeMaster, R. (2009). Applications of physics education research to skiing pedagogy for coaches and instructors. In *E. Müller, S. Lindinger, T. Stöggl (Eds.), Science and Skiing IV* (pg. 347-355). Maidenhead: Meyer & Meyer Sport (UK) Ltd.

Loland, S. (2009). Alpine skiing technique – practical knowledge and scientific analysis. In *E. Müller, S. Lindinger, T. Stöggl (Eds.), Science and Skiing IV* (pg. 43-58). Maidenhead: Meyer & Meyer Sport (UK) Ltd.

Mildner, E., Lembert, S. & Raschner, C. (2010). Influence of ski boots on balance performance. *Sportverletz Sportschaden*, 24(1), 31-35.

Muller, E. & Schwameder, H. (2003). Biomechanical aspects of new techniques in alpine skiing and ski-jumping. *Journal of Sport Sciences*, 21, 679-692.

Natri, A., Beynnon, B. D., Ettlinger, C. F., Johnson, R. J. & Shealy, J. E. (1999). Alpine ski bindings and injuries. *Sports Medicine*, 28, 35-48.

Noé, F. & Paillard, T. (2005). Is postural control affected by expertise in alpine skiing? *British Journal of Sports Medicine,* 39(11), 835-837.

Noé, F., Amarantini, D. & Paillard, T.J. (2009). How experienced alpine-skiers cope with restrictions of ankle degrees-of-freedom when wearing ski-boots in postural exercises. *Journal of Electromyography and Kinesiology,* 19(2), 341-346.

Nourrit, D., Delignières, D., Caillou, N., Deschamps, T. & Lauriot B. (2003). On discontinuities in motor learning: a longitudinal study of complex skill acquisition on a ski-simulator. *Journal of motor behavior*, 35(2), 151-170.

Philippe, M., Ruedl, G., Feltus, G., Woldrich, T. & Burtscher, M. (2014). How frequent and why are skiers and snowboarders falling? *Sportverletz Sportschaden*, 28(4), 188-192.

Raschner, C., Muller, L. & Hildebrandt, C. (2012). The role of a relative age effect in the first Winter Youth Olympic Games in 2012. *British Journal of Sports Medicine*, 46(15), 1038-1043.

Ružić, L., Rađenović. O. & Tudor. A. (2008). The predictive power of balance bord: tests for „on-the-skis" balance performance. In *Proceedings book of the 5th International Scientific Conference on Kinesiology "Kinesiology Research Trends and Applications"* (196-200). Zagreb: University of Zegreb, Faculty of Kinesiology.

Senner, V., Lehner, S. & Bohm, H. (2009). Equipment development and research for more performance and safety. In *E. Müller, S. Lindinger, T. Stöggl (Eds.), Science and Skiing IV* (pg. 110-133). Maidenhead: Meyer & Meyer Sport (UK) Ltd.

Spörri, J., Kröll, J., Schwameder, H., Schieferműller, C. & Műller, E. (2012). Course setting and selected biomechanical variables related to injury risk in alpine ski racing: an explorative case study. *British Journal of Sports Medicine*, 46(15), 1072-1077.

Staniszewski, M., Zybko, P. & Wiszomirska, I. (2016). Influence of a nine-day alpine ski training programme on the postural stability of people with different levels of skills. *Biomedical Human Kinetics*, 8(1), 24–31.

Tchórzewski, D., Bujas, P. & Jankowicz-Szymańska, A. (2013). Body posture stability in ski boots under conditions of unstable supporting surface. *Journal of Human Kinetics*, 8(38), 33-44.

UDC 796.926:796.2

Thiel, C., Rosenhagen, A., Roos, L., Huebscher, M., Vogt, L. & Banzer, W. (2009). Physiologic characteristics of leisure alpine skiing and snowboarding. In *E. Müller, S. Lindinger, T. Stöggl (Eds.), Science and Skiing IV* (pg. 516-522). Maidenhead: Meyer & Meyer Sport (UK) Ltd.

Turnbull, J.R., Kilding, A.E. & Keogh, J.W.L. (2009). Physiology of skiing. *Scandinavian Journal of Medicine & Science in Sport*, 19(2), 146-155.

Wojtyczek, B., Pasławska, M. & Raschner, C. (2014). Changes in the balance performance of polish recreational skiers after seven days of alpine skiing. *Journal of Human Kinetics*, 44, 29-40.

Zemkova, E. (2014). Sport-specific balance. *Sports Medicine*, 44(5), 579-590.

ORIGINAL SCIENTIFIC PAPER

Systemic Mapping of High-Level Women's Volleyball using Social Network Analysis: The Case of Attack Coverage, Freeball, and Downball

Marta Hurst[1], Manuel Loureiro[1], Beatriz Valongo[1], Lorenzo Laporta[1], Pantelis T. Nikolaidis[2] and José Afonso[1]

Affiliations: [1]University of Porto, Centre of Research, Education, Innovation and Intervention in Sport, Faculty of Sports, Porto, Portugal, [2]Hellenic Army Academy, Department of Physical and Cultural Education, Athens, Greece

Correspondence: Marta Hurst, University of Porto, Faculty of Sports, Rua Dr. Plácido Costa, 91, 4200-450, Porto, Portugal. E-mail: martahurst.22@gmail.com

ABSTRACT This work analysed team sports as complex systems in which behavioural variables need to be taken into consideration when studying performance. Within this understanding, the use of Social Network Analysis constitutes a useful research path. As such, this research analysed two of the least studied game complexes: attack coverage and freeball and downball, in eight matches from the first Group Stage of the Women's World Grand Prix 2015, comprising a total of 1,264 rallies. Eigenvector centrality values were calculated, with each behavioural variable counted as a node and their connections as edges. The results showed that playing in off-system is central in both complexes, although more so in attack coverage than in freeball and downball situations. Results also showed that although freeing a higher number of players for attack action is potentially advantageous, such action would become a disadvantage when faced with an effective blocking action and the sudden need for effective attack coverage. Overall, this study showed that volleyball coaches should take off-system game moments into stronger consideration and devise a strategy of play that will turn off-system play into an advantage.

KEY WORDS Off-system Gameplay, Performance Analysis, Social Network Analysis, Volleyball.

@MJSSMontenegro
SYSTEMIC ANALYSIS OF HIGH-LEVEL VOLLEYBALL
http://mjssm.me/?sekcija=article&artid=132

Introduction

The study of networks pervades all of science, from neurobiology to statistical physics (Strogatz, 2001). In fact, although systemic analysis has existed for several decades (see the General Systems Theory developed in the first half of the 20th century by Bertalanffy (1950) and Boulding (1956), among others), in the last two decades a wider range of scientific fields have been displaying a broader interest in research into complex systems (Strogatz, 2001). Furthermore, recent trends in the psychology of learning, namely in embodied cognition, stress the learner-environment relationship, stating that learning takes place in dynamic contexts with the acquisition of knowledge occurring as a consequence of indeterminate interactions between learners and the environment (Barab & Kirshner, 2001). As such, performance and learning should be viewed as "constrained by key features of the organism-environment system including the structure and physics of the environment, the biomechanics and morphology of individual and specific task constraints" (Chow, Davids, Hristovski, Araújo, & Passos, 2011, p.190).

Learning and performance are two tenets of any sports activity and, as such, any study of sports performance would benefit from an approach that considers the systemic relation between the desired action outcome and its constraints. Traditionally an analytical approach in science breaks down a system into its simplest components while considering that the introduction of a change in a variable would allow the deducing

Accepted after revision: June 30 2016 | First published online: March 01 2017

Conflict of interest: None declared.

of general laws, which would, in turn, allow predicting properties of the system under different conditions (Gréhaigne, Bouthier & David, 1997). However, the additive laws at play in the aforementioned deduction process do not function in complex systems making necessary the use of a systemic approach (Gréhaigne et al., 1997). Before the emergence of systemic analysis, the formal approaches used for explaining phenomena had been linear, stepwise, and sequential in nature, but formal methods relying on rational sequential logic are of limited utility for problems emerging from complex systems (Keating, Kauffman & Dryer 2001).

Sports, particularly team sports, can, therefore, be approached in a productive manner using the framework of non-linear, complex systems. Regarding such an approach to sports activity, the works of McGarry (with Anderson, Wallace, Hughes & Franks in 2002, and with Franks in 2006) and Lebed (2006 & 2007) demonstrate two different approaches. The first states that a sports contest can be considered as a non-linear and self-organizing system, based on dynamic principles. The same author also states "a dynamical system is a type of complex system, one which regularity self-organizes from within as a result of information exchanges that occur both inside and outside the system" (2006, p.48).

In contrast, Lebed (2006), in response to McGarry (2002), stated that although opponents competing could be interpreted as a symbiotic relation, and therefore as a system, such a concept "is nothing but an appearance of systematic wholeness" (2006, p.36). This impossibility of wholeness occurs, according to Lebed (2006), because of the antagonistic feature of the match itself, where each team's aim is directly opposed to the other's. As such, according to Lebed "the one case in which the game process becomes a system is a cooperative game" (2006, p.36). Independently of particular takes such as the two exemplified by the quotes above, the usefulness of a systemic approach is prevalent in team sports (McGarry 2002; Lebed 2006), in as much as there are several interactions between elements on both teams.

While taking sports as a complex system, McGarry (2009) underlines six issues that can affect performance analysis of which two are of particular relevance to this study: a) the interactions between opposing players and/or teams as being key for interpreting game behaviour, and b) the context in which sports behaviours are produced as offering valuable information for game analysis. Both points underline the importance of a systemic analysis in sports performance, and the need for researchers to focus on the effects emerging from the interactions between variables and sets of variables. In fact, according to Gréhaigne, Godbout, and Bouthier "in any team sport, players are faced with four interrelated tasks: an attack on the adverse camp, defence of their own camp, opposition to opponents, and cooperation with partners" (2001, p. 60). The opposing team can thus be conceptualized as "problem" in as much as it stands in the way of the other team's victory. Effective problem solving for complex issues will do better with an approach capable of addressing the uncertain dynamic behaviour that is characteristic of complex systems. Thus, the option for a systems approach analysis in problem solving will provide an overall consideration of the 'problem system' in which there are two critical points: (1) problems cannot be isolated from the system that is producing the problematic behaviour; and (2) the problem system cannot be understood independently of the context within which it is embedded (Keating, 2001). Taking team sports as open/complex systems and considering ineffective play action as the problem, we can see how contextual and behavioural variables need to be taken into consideration when studying ways to improve team performance.

In volleyball, different types of variables have been studied and analysed. However, few studies have focused on systemic mapping of the relationships between sets of variables (see Costa Afonso, Barbosa, Coutinho, and Mesquita. (2014) and Marcelino, Afonso, Moraes, and Mesquita. (2014) for exceptions). As Reed and Hughes (2006) stated in relation to patterns formed in open (complex) systems, "small changes to the system prompt large (nonlinear) changes in the system" (p.114). Due to this complexity, Sports Sciences have been investing in methods to enhance the training processes; one such promising method is Social Network Analysis (SNA). This latter method, with its foundation in the mathematical field of Topology, is useful in addressing the issue of interdependencies in the data inherent in team structures (Lusher & Robins 2010), both in quantitative (e.g. number of connections) and qualitative terms (e.g. degree and quality of connectedness). As such, SNA proves to be useful in identifying and measuring the centrality of game variables, which will deliver useful information for planning and developing team tactics and their intrinsic dynamics.

This research uses SNA to scrutinize how two often-neglected game complexes operate in high-level women's volleyball: attack coverage (KIV), and – freeball and downball (KV; two of the less studied complexes in volleyball, probably because they occur in a minor percentage of the game in comparison to the other complexes). Competition in high-level volleyball has evolved to such a demanding level of performance, that every opportunity to score a point should be valued (Laporta, Nikolaidis, Thomas & Afonso, 2015). As such, freeball and downball situations, although occurring in a smaller percentage in relation to the other game complexes, are important and should be studied so that a team can ensure scoring in a favourable situation. In women's volleyball, it is common to have longer rally points than in men's volleyball (Esper, 2003). The former occurs because there are several situations of KIII and KIV, where in the latter, a team can recover the ball possession after the opponents' block. As such, it is important to study KIV, especially in women's volleyball, because it will allow a team to regain an opportunity to score and thus produce a more efficient sports performance.

UDC 796.325-055.25

Methods

Sample

The analysed World Grand Prix games were part of two groups: Group A – Brazil (3rd place in the competition and 3rd place in the rankings of the Fédération Internationale de Volleyball - FIVB); Japan (6th place in the competition and 5th in the FIVB ranking); Serbia (8th place in the competition and 6th place in the FIVB ranking) and Thailand (9th place in the competition and 13th in the FIVB ranking). Group B – Russia (2nd place in the competition and 4th in the FIVB ranking); China (4th place in the competition and 2nd in the FIVB ranking); Germany (7th place in the competition and 11th in the FIVB ranking) and the Dominican Republic (12th place in the competition and 7th in the FIVB ranking). In the process, a total of eight matches (29 sets; 1,264 rallies) were analysed.

Instruments

The video recordings of the matches offered both a lateralized view (aligned with the net) and an overview of the court. The recordings of the eight matches were freely available on the site youtube.com. In terms of observers involved in the study, the former were previously trained so as to guarantee consistency in the coding data criteria register, both for intra- and inter-observer reliability calculations. This previous training consisted of viewing and registering eight games from different high-level competitions (men and women). A minimum level of 0.75 for Cohen's Kappa calculation of reliability was established. All registered variables resulted in Kappa values above 0.81.

Variables

In this research six-game complexes were considered (Muñoz, 2007): serve (K0), side-out (KI), side-out transition (KII), transition (KIII), attack coverage (KIV) and freeball and downball (KV); the latter two were analysed. Court zones were defined according to the FIVB game rules. Some variables occur in both complexes, while others are unique to each complex. As such, the common variables to both KIV and KV are the setting zone, attack zone, and attack tempo. The variables that differentiate the two complexes are the number of attackers' available pre-KIV and the number of coverage lines (within KIV), and freeball or downball distinction, and ball within front row or back row of the court (within KV).

KIV is the only complex that can follow all other complexes (except for K0), as it is defined as the act of regaining ball possession immediately after the ball having been deflected by the opposing team's block and returned to the attacker's court (Laporta et al. 2015). As such, according to the latter authors and to Selinger and Ackermann-Blount (1986), the variables in KIV are: number of attackers available pre-KIV, which refers to the number of players available before the setting to attack the opposing team (register of observed data done from 1 player available up to a maximum of 4 players); number of coverage lines - this refers to the number of lines that constitute the attack coverage system (register of the observed data done from a minimum of 1 line up to a maximum of 3 lines); setting zone (register made following Laporta et al. (2015) and adapted from Esteves and Mesquita (2007): A- the setter can play with all of his attackers; B- the setter has space-time difficulties to set to the middle blocker, although he can still set quick plays to the outer players; C- the setter has only the options to set to the outer hitters); attack zone (Zones 1 to 6); attack tempo (register made following Afonso and Mesquita (2007) and Costa, Afonso, Brant, and Mesquita (2012): 1- the attacker is in the air, or will be jumping during or rapidly after the setting; 2- after the setting the attacker takes two steps; 3- the attacker takes three or more steps after the setting).

The KV complex encompasses freeball situations or downball situations (Hileno & Buscà, 2012). As such, the variables of this complex are: distinction between freeball - the opponent delivers a ball with no aggressive/powerful intention, and downball - the ball has a more downwards trajectory than the freeball and can be more unpredictable; target zone of KV (attack zone - Zones 2, 3 and 4; or defence zone - Zones 1 to 6); setting zone, attack zone and attack tempo also are a part of KV, and have the same definition as presented above for KIV.

Statistical analysis

Social Network Analysis was performed using the measurement of eigenvector centrality. The data collected was initially registered on an Excel® worksheet and then subjected to statistical analysis using IBM® SPSS® Statistics (Version 21, U.S.A.) to perform quality control and exploratory cross table statistics of the data. The eigenvector centrality measure was obtained by using the software Gephi© 0.8.2-beta (Version 10.10.3, France). The insertion of the collected data in this software produced a total of 43 nodes and 356 bridges. Eigenvector centrality (Bonacich, 1972) is a concept based on the idea that a node is more central if it is related with nodes that are themselves also central. As such, the centrality of a node does not depend solely on the number of its adjacent nodes but also on their characteristics.

Concerning the reliability of the statistical procedures undertaken, and the previous testing of the instrument notwithstanding, specific testing was performed. For the purposes of the inter-observer reliability of the analysis of the current sample, 50.9% (n = 216) of the rallies were reanalysed (above the 10% suggested by Tabachnick & Fidell, 2000). Cohen's Kappa values respected the minimum value of 0.75 suggested in specialized literature (Fleiss, 2003), having ranged from 0.81 to 1.

Results

The overall Social Network Analysis mapping is presented below.

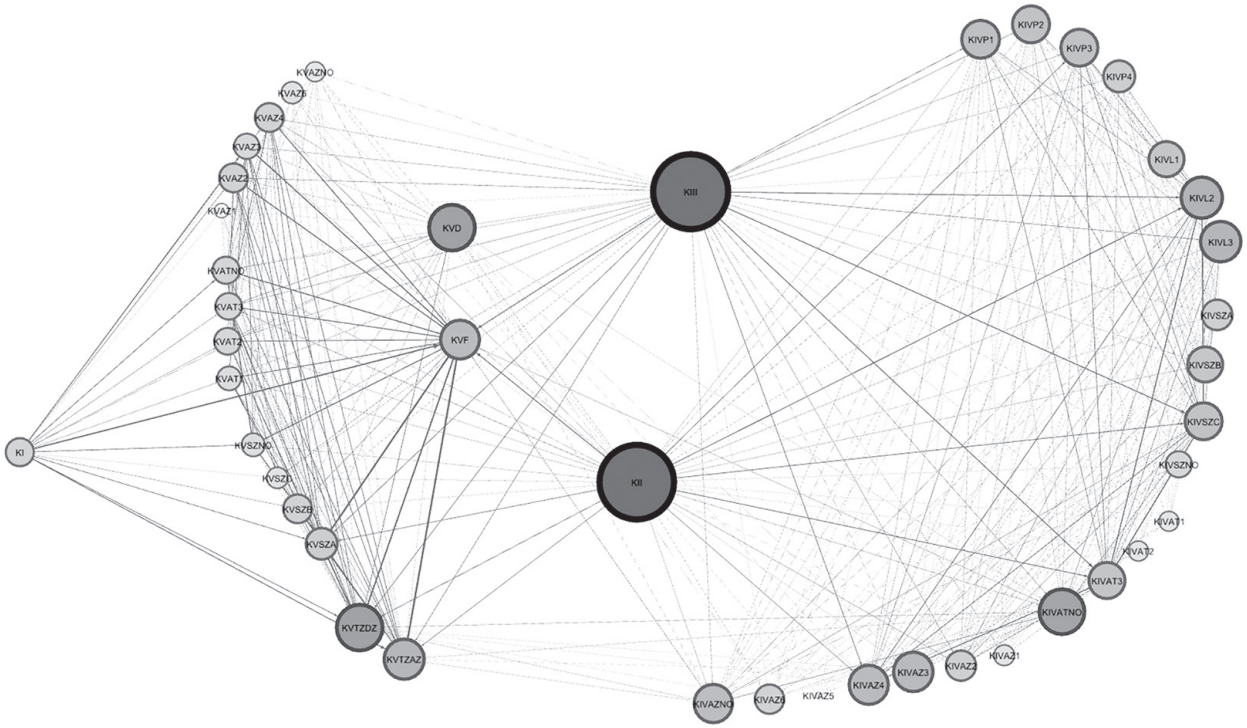


FIGURE 1. Overall mapping of the Social Network Analysis (Gephi Software)

Concerning KIV (see Table 1), the eigenvector values obtained for the number of attackers available pre-KIV were very similar (KIVP1 with a value of 0.55, and KIVP2 and KIVP3 with a value of 0.54). Regarding the category number of coverage lines, two values stood out: coverage lines with two and three lines (KIVL2=0.59 and KIVL3=0.62, respectively). Concerning the setting zone, zones associated with off-system playing (i.e. under non-ideal conditions: KIVSZC=0.54 and KIVSZB=0.52) presented the highest eigenvector values. The two highest values found within the attack zone belonged to KIVAZ3 and KIVAZ4 (both with a value of 0.57). Finally, within the attack tempo category, KIVATNO (0.64) has the highest value, very much above that of KIVTA3 (0.53), the second highest register.

TABLE 1 Eigenvector Values for Attack Coverage

Number of attackers available pre-KIV (KIVP)	One attacker (KIVP1)	Two attackers (KIVP2)	Three attackers (KIVP3)	Four attackers (KIVP4)			
	0.55	0.54	0.54	0.48			
Number of coverage lines (KIVL)	One line (KIVL1)	Two lines (KIVL2)	Three lines (KIVL3)				
	0.52	0.59	0.62				
Setting Zone (KIVSZ)	SZ A (KIVSZA)	SZ B (KIVSZB)	SZ C (KIVSZC)	SZ Not Occurring (KIVSZNO)			
	0.46	0.52	0.54	0.41			
Attack Zone (KIVAZ)	AZ 1 (KIVAZ1)	AZ 2 (KIVAZ2)	AZ 3 (KIVAZ3)	AZ 4 (KIVAZ4)	AZ 5 (KIVAZ5)	AZ 6 (KIVAZ6)	AZ Not Occurring (KIVAZNO)
	0.34	0.46	0.57	0.57	0.17	0.45	0.56
Attack Tempo (KIVAT)	AT 1 (KIVAT1)	AT 2 (KIVAT2)	AT 3 (KIVAT3)	AT Not Occurring (KIVATNO)			
	0.33	0.34	0.53	0.64			

Regarding KV (see Table 2), the most common ball type was downball (0.65), as opposed to freeball (0.56), and the target zone that was more commonly solicited was the defensive zone (KVTZDZ=0.65). The highest eigenvector value for setting zone was found within Zone A (0.48), followed by Zone B (0.44). Regarding the variable attack zone, there were two zones with the same high eigenvector value (0.44), Zone 2 and Zone 4, followed closely by Zone 3 (0.40); it is important to underline that there were no attacks performed in Zone 5 and, as such, this category was excluded from the table. Regarding attack tempo all four categories presented relatively close values, with KVTA1 having the only different value from all other categories (0.38 eigenvector value, as opposed to the 0.42 found in all others).

UDC 796.325-055.25

TABLE 2 Eigenvector Values for Freeball and Downball Situations

Freeball or Downball (KVFOD)	Freeball (KVF)	Downball (KVD)				
	0.56	0.65				
Target Zone of KV (KVTZ)	Defense Zone (KVTZDF)	Attack Zone (KVTZAZ)				
	0.65	0.59				
Setting Zone (KVSZ)	SZ A (KVSZA)	SZ B (KVSZB)	SZ C (KVSZC)	SZ Not Occurring (KVSZNO)		
	0.48	0.44	0.35	0.37		
Attack Zone (KIVAZ)	AZ 1 (KVAZ1)	AZ 2 (KVAZ2)	AZ 3 (KVAZ3)	AZ 4 (KVAZ4)	AZ 6 (KVAZ6)	AZ Not Occurring (KVAZNO)
	0.27	0.44	0.40	0.44	0.36	0.33
Attack Tempo (KVAT)	AT 1 (KVAT1)	AT 2 (KVAT2)	AT 3 (KVAT3)	AT Not Occurring (KVATNO)		
	0.38	0.42	0.42	0.42		

To conclude, Table 3 presents the eigenvector values of the three complexes that will not be discussed in this paper. As can be seen in the table below, KIII and KII have much higher eigenvector values than KI.

TABLE 3 Eigenvector Values for Side-out, Side-out Transition, and Transition

Side-out (KI)	***Transition (KII)***	***Side-out Transition (KIII)***
0.43	0.99	1.00

Discussion

Learning and performance are tenets of any sports activity and should be viewed as being constrained by key features of the organism-environment system (Barab & Kirshner, 2001). As such, the study of sports performance would benefit from an approach that considers the systemic relation between the desired action outcome and its constraints. Therefore, while a wide body of research using Match Analysis has focused on the efficacy of actions, here the focus was on the behavioural aspects of performance. This paper analysed two complexes of the volleyball game, namely attack coverage (KIV) and freeball and downball (KV), in women's high-level matches. The analysis was based on SNA, namely measuring the eigenvector values of each complexes' variables.

The data collected for KIV showed that (within the variable number of attackers available pre-KIV) the most common situation was having only one player available for an offensive action before an attack coverage (KIVP1=0.55). If the team that is going to be in KIV only has one player available to attack, it is more likely that the opposing team will have a more cohesive block formation to prevent a successful attack. The availability of only one attacker pre-KIV might promote the possibility of a routinized intention to participate in attack coverage, resulting in attributing a high importance to KIV, notwithstanding its low presence in the game. This latter characteristic should be taken into consideration in team sports coaching, as it shows that a low occurrence in the game may, nevertheless, represent a significant opportunity to gain some advantage. Such a characteristic of team sports dynamics was made apparent by Lorenzo et al. (2010), as they presented situations that were less frequent but nonetheless had a direct relation to winning in U-16 male basketball (see reference to turnover in the close games category). However, the situations with two and three attackers available have registered values very close to the one attacker situation (KIVP2 and KIVP3 both with 0.54 eigenvector). The noticeable difference was when there were four attackers available (KIVP4=0.48). In this situation, the degree of uncertainty faced by the opposing block was higher. As such, the blocking action might be less effective under such constraints. Consequently, the attacking team would benefit from a situation in which there is a smaller need for attack coverage. This would be an advantage, but in the case of an effective block action the attacking team, by having four players in attacking mode, would not have the necessary elements available for attack coverage action.

Recent studies (such as Laporta et al., 2015) carried out on coverage lines showed this game complex is not as structured a system as previously thought. In fact, there was high variability in the disposition of the players within the coverage line(s), as this emerged as a consequence of the momentary constraints of the game, and not a structured, previously developed formation. Coverage lines thus seem to be created out of the players' availability, and this is influenced by several factors of the game both within the attacking team and the opposing team. Regarding the variable number of coverage lines, the highest eigenvector value registered in this study was found within the category two coverage lines (KIVL2=0.59). The category three coverage lines emerged as a close second (0.58), while one-line coverage had the lowest eigenvector value (0.52). This data is in agreement with the results found by Laporta et al. (2015), for which the authors found the same relative frequency of coverage lines: two coverage lines occurred in 60.3% of the KIV situations, followed by three

coverage lines (33.6%) and finally only one coverage line (4.7%). However, the data collected in this study showed a smaller difference in frequency of these coverage line scenarios, since all the coverage frequencies observed in this study stood much closer in range.

The results for the variable setting zone showed that in KIV the highest value belonged to Setting Zone C (0.54), followed by Setting Zone B (0.52), showing that in KIV it was more common to construct play in off-system situations. The higher presence of Setting Zones B and C is probably a result of the unpredictable ball deflection from the opposing block. This unpredictability results in the unavoidability of playing off-system. In fact, when following an environmental and systemic approach to team sports analysis off-system situations should be understood to be highly relevant. According to Silva, Garganta, Araújo, Davids, and Aguiar, (2013, p.767) in their study on team coordination, "in most sports, there is no time for team members to plan deliberately during performance, which leads to no other option than ongoing adaptation of behaviours". Thus, teams who can set under less favourable conditions, and also have players (not only the setter) who can perform a second contact with reasonable quality would be in an advantageous position.

Concerning the variable attack zone, two categories stood out: Attack Zone 3 and Attack Zone 4 (both with an eigenvector value of 0.57). However, bordering this value was the value found in the category KIVAZNO (0.58). It was expected that, in an off-system situation, Zone 4 would be a clear option, as it is an outer net zone and therefore easier to set the ball there (Castro and Mesquita, 2008). For the same reason, the high value of Zone 3 comes as a surprise, as it is a central net zone, and therefore it is more difficult to set, especially with the registered higher occurrences of Setting Zones B and C. The fact that KIVAZNO has a high presence in the collected data shows that teams cannot perform a jumping attack very often. This means that when there is coverage, and after a first and second contact, teams would (a) return the ball to the opposing side in a non-aggressive gesture (freeball), (b) return the ball to the opposing side with some aggressive gesture, e.g. a non-jumping attack (downball) or (c) wouldn't be able to return the ball to the opposing side. A wider availability of attack zones could work as a way to increase the opponents' uncertainty and therefore could be a way to enhance the team's success. Therefore, coaches should practice KIV gameplay using different attack zones, either by refining the ability to set to several areas or by having more attacking players available.

Regarding attack tempo in KIV, the eigenvector value with the most influence was found in the category KIVATNO (0.64). This value could have the same threefold explanation as the category KIVAZNO referred to above. The second highest eigenvector value found was 0.53 (KIVAT3), representing the slowest attack tempo. It is expected that with a more off-system type of play slower attack tempos would emerge. Therefore, as a way to improve women's volleyball play in KIV, teams should practice in order to be able to use quicker attack tempos even under non-ideal conditions. These latter tempos would work as a way to unbalance the opposing block formations and consequently improve the chances of winning the point for the attacker (Afonso and Mesquita, 2009).

With respect to KV, data showed that there was a clear distinction between the eigenvector values obtained for freeball (KVF=0.56) and downball (KVD=0.65) situations. This means that when teams are forced to return the ball in less favourable conditions, they play the ball in a way that creates more difficulty for the opposing team (downball). Thus, in future studies, it would be an advantage to keep the distinction between these two types of ball return, as they could produce different results. Possibly, the suggestion to separate them into different game complexes would be reasonable. There is also a clear difference within the category target zone of KV as the defence zone had an eigenvector value of 0.65, compared to the 0.59 value obtained by the attack zone. This difference could be explained by the teams' need to have more time to reorganize their block and defence formations: something made easier by a longer ball trajectory.

The data collected for the category setting zone displayed zone A (0.48) as the most central category. This value could be expected in as much as the ball that is returned in freeball or downball usually has a very low degree of difficulty. Nonetheless, the values of KVSZB (0.44) and KVSZNO (0.37) were relatively close to KVSZA. The KVSZNO value emerged with some influence within KV possibly because it comprises situations in which the ball was returned after a first contact and a net player would be able to attack or block the ball instantly. Although Setting Zone C registered the lowest value (0.35), it showed that even when the returned ball was not challenging there was still off-system playing. In future studies, it might prove useful to separate downball and freeball situations to assess when Setting Zone C occurs.

For attack zones, Zones 2 and 4 exhibited the highest values (both with 0.44), followed closely by Zone 3 (0.40). These values show a predominant and widespread use of the front row within KV, which could be expected in association with the high value of KVSZA. It is important to underscore that there were no registered attacks within Zone 5 in KV, probably a result of the libero's presence. However, exploring a greater diversity of attack zones in KV, namely the use of Zone 5, could become an advantage, as it would create more uncertainty to the opposing teams' block formations. Regarding attack tempo, the highest eigenvector value was 0.42, and it was found in three of the four available categories (KVAT2, KVAT3, and KVATNO). These values show that (a) even when with favorable conditions to build-up play, teams do not use the faster attack tempo available (Attack Tempo 1) and (b) KVATNO is related to situations in which the ball is returned after a first contact (as described above in relation to KVSZNO). The KVAT2, KVTA3 and KVATNO common value could be related to the value of KVSZC. The fact that the value found within attack tempo 3 is relevant in KV,

UDC 796.325-055.25

supports the fact that in KV there is also a need to play in off-system conditions, as this is the slowest tempo available, and it is usually associated with Setting Zones B and C. These findings strengthen the argument in favor of teams increasing their use of quicker attack tempos, namely Attack Tempo 1, thus diminishing the opposing teams' block cohesiveness (Afonso and Mesquita, 2009).

Conclusion

This research underscored the usefulness of SNA in high performance sports analysis in as much as it allows for the relational study of a high number of variables present in a match situation. Of particular importance, eigenvector centrality emerged as a useful metric, as it represents more than the simple number of connections each node establishes, instead of weighing those connections with the number of secondary and higher-order connections. It was further demonstrated that by separating the game into different complexes, distinct patterns become apparent: a fact that is relevant in helping to provide guidelines for volleyball coaching. The paper focused on two of the less studied complexes in the game (KIV and KV) and, as such, the data collected will be of use for those interested in a deeper analysis of game strategies. This investigation further showed that playing in off-system conditions was frequent in both complexes, although more so in KIV than in KV; volleyball coaches should, therefore, take into stronger consideration the off-system game moments and devise a strategy of play that could turn off-system play into an advantage and not a difficulty.

REFERENCES

Afonso, J. and Mesquita, I. (2007). Estudo Piloto Acerca da Relação entre Jogada de Ataque e Tempo de Ataque em Voleibol Feminino. *Revista Portuguesa de Ciências do Desporto*, 7, 46-47.

Afonso, J. and Mesquita, I. (2009). Determinants of Block Cohesiveness and Attack Efficacy in High-Level Women's Volleyball. *European Journal of Sports Science*, 11, 69-75.

Barab, A. and Kirshner, D. (2001). Guests editors' Introduction: Rethinking Methodologies in the Learning Sciences. *The Journal of the Learning Sciences*, 10, 5-15.

Bertalanffy, L. (1950). An Outline of General System Theory. *British Journal for the Philosophy of Science*, 1, 134-165.

Bonacich, P. (1972). Factoring and Weighting Approaches to Status Scores and Clique Identification. *Journal of Mathematical Sociology*, 2, 113-120.

Boulding, K. (1956). General Systems Theory – The Skeleton of Science. *Management Science*, 3, 197-208.

Castro, J. and Mesquita, I.. (2008). Estudo das Implicações do Espaço Ofensivo nas Características do Ataque no Voleibol Masculino de Elite. *Revista Portuguesa de Ciências do Desporto*, 8, 114-125.

Chow, J., Davids, K., Hristovski, R, Araújo, D. and Passos, P. (2011). Nonlinear Pedagogy: Learning Design for Self-organizing Neurobiological Systems. *New Ideas in Psychology*, 29, 189-200.

Costa, G., Afonso, J., Barbosa, R., Coutinho, P. and Mesquita, I. (2014). Predictors of Attack Efficacy and Attack Type in High-Level Brazilian Women's Volleyball. *Kinesiology*, 46, 242-248.

Costa, G., Afonso, J., Brant, E. and Mesquita, I. (2012). Differences in Game Patterns between Male and Female Youth Volleyball. *Kinesiology*, 44, 60-66.

Esper, A. (2003). Tiempos de Juego y Pausa en el Voleibol Femenino y Masculino. *Revista Digital Buenos Aires*, 64.

Esteves, F. and Mesquita, I. (2007). Estudo da Zona de Distribuição no Voleibol de Elite Masculino em Função do Jogador Distribuidor e do Tipo de Passe. *Revista Portuguesa de Ciências do Desporto*, 7, 36-37.

Fleiss, L. (2003). *Statistical Methods for Rates and Proportions*: Interscience.

Gréhaigne, J., Bouthier, D. and David, B. (1997). Dynamic-system Analysis of Opponent Relationships in Collective Actions in Soccer. *Journal of Sports Sciences*, 15, 137-149.

Gréhaigne, J., Godbout, P. and Bouthier, D. (2001) The Teaching and Learning of Decision Making in Team Sports. *National Association for Physical Education in Higher Education*, 53, 59-76.

Hileno, R. and Buscà, B. (2012). Herramienta Observacional para Analizar la Cobertura del Ataque en Voleibol. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte*, 12, 557-570.

Keating, C., Kauffman, P. and Dryer, D. (2001). A Framework for Systemic Analysis of Complex Issues. *Journal of Management Development*, 20, 772-784.

Laporta, L., Nikolaidis, P., Thomas, L. and Afonso, J. (2015). The Importance of Loosely Systematized Game Phases in Sports: The Case of Attack Coverage Systems in High-Level Women's Volleyball. *Montenegrin Journal of Sports Science and Medicine*, 4, 19-24.

Lebed, F. (2006). System Approach to Games and Competitive Playing. *European Journal of Sport Science*, 6, 33-42.

Lebed, F. (2006). A Dolphin only looks Like a Fish: Players' Behavior Analysis is not enough for Game Understanding in the Light of the Systems Approach - A Response to the Reply by McGarry and Franks. *European Journal of Sport Science*, 7, 55-62.

Lorenzo, A., Gómez, M., Ortega, E., Ibáñez, S. and Sampaio, J. (2010). Game Related Statistics which Discriminate between Winning and Losing Under-16 Male Basketball Games. *Journal of Sports Science and Medicine*, 9, 664-668.

Lusher, D. and Robins, G. (2010). The Application of Social Network Analysis to Team Sports. *Measurement in Physical Education and Exercise Science*, 14, 211-224.

Marcelino, R., Afonso, J., Moraes, C. and Mesquita, I. (2014). Determinants of Attack Players in High-Level Men's Volleyball. *Kinesiology*, 46, 234-241.
McGarry, T. (2009). Applied and Theoretical Perspectives of Performance Analysis in Sport: Scientific Issues and Challenges. *International Journal of Performance Analysis in Sport*, 9, 128-140.
McGarry, T., Anderson, D., Wallace, S., Hughes, M. and Franks, I. (2002). Sport Competition as a Dynamical Self-Organizing System. *Journal of Sports Sciences*, 20, 771-781.
McGarry, T. and Franks, I. (2007). System Approach to Games and Competitive Playing: Reply to Lebed (2006). *European Journal of Sports Sciences*, 7, 47-53.
Muñoz, M. (2007). *Construcción de un Sistema Observacional para el Análisis de la Acción de Juego en Voleibol*: Universidade da Coruña.
Reed, D. and Hughes, M. (2006). An Exploration of Team Sport as a Dynamical System. *International Journal of Performance Analysis in Sport*, 6, 114-125.
Ruhnau, B. (2000). Eigenvector-Centrality – A Node-Centrality?. *Social Networks*, 22, 357-365.
Selinger, A. and Ackermann-Blount, J. (1986). *Arie Selinger's Power Volleyball*: St. Martin's Press.
Silva, P., Garganta, J., Araújo, D., Davids, K. and Aguiar, P. (2013). Shared Knowledge or Shared Affordances? Insights from an Ecological Dynamics Approach to Team Coordination in Sports. *Sports Medicine*, 43, 765-772.
Strogatz, S. (2001). Exploring Complex Networks. *Nature*, 410, 268-276.
Tabachnick, B. and Fidell, L. (2000). *Using Multivariate Statistics*: Harper & Row Publishers.
Travassos, B., Araújo, D., Correia, V. And Esteves, P. (2010). Eco-dynamics Approach to the Study of Team Sports Performance. *The Open Sports Science Journal*, 3, 56-57.

UDC 796.325-055.25

Pulmonary Function in Prepubescent Boys: The Influence of Passive Smoking and Sports Training

Mario Jeličić[1], Ognjen Uljević[1] and Nataša Zenić[1]

Affiliations: [1]University of Split, Faculty of Kinesiology, Split, Croatia

Correspondence: Ognjen Uljević, University of Split, Faculty of Kinesiology, Teslina 6, 21 000 Split, Croatia.
E-mail: ouljevic@kifst.hr

ABSTRACT In this paper, we studied prepubescent boys (N = 75; 11.3 years ± 2 months) divided into three groups: two experimental groups and age-paired, non-systematically physically engaged controls (N = 25). The experimental groups consisted of 27 basketball players, and of 23 dinghy sailors. The pulmonary function was established measuring the large airway variables (inspiratory-vital-capacity, forced-vital-capacity, one-second-forced-expiratory-volume) and small airway variables (peak-expiratory-flow, and maximal-expiratory-flow after 50% and 75% exhalation). All variables were measured in absolute values and then presented and compared in relative values - predicted for age and stature. Using the simple originally constructed questionnaire, passive smoking status was observed, and the subjects were additionally sub-sampled as passive smokers, or non-exposed to passive smoking. The multivariate- analysis-of-the-variance (MANOVA) showed significant dominance ($p < 0.05$) of the experimental groups in the large airways variables and small airways variables, for the NS exclusively. No significant MANOVA differences were found between the basketball players and sailors, and between the non-exposed to passive smoking and passive smoking in any of the studied groups. The results of the present study indicate a positive influence of the systematic physical exercising on the pulmonary function, with no differential effects of the two-year basketball and dinghy sailing sports training on the pulmonary function.

KEY WORDS Respiratory Status, Children, Kinesiology, Factor Analysis, Test Construction, Croatia.

@MJSSMontenegro
PULMONARY STATUS IN YOUNG ATHLETES AND NONATHLETES
http://mjssm.me/?sekcija=article&artid=133

Introduction

It is accepted and well documented that respiratory volumes, flows, and capacities (pulmonary function (PF)) of growing children and adolescents change mostly as a function of age and consequently as a function of body height (BH). It is defined by an increase in the lung volume, which naturally follows an increase of body proportions, mostly defined by an increase of the BH. However, PF is also dependent on differences in the functionality of the respiratory system, not necessarily related to growth (Peric, Cavar, Zenic, Sekulic, & Sajber, 2014). One of such factors is smoking status. Passive smoking (PS) negatively influences RS (Haby, Peat, & Woolcock, 1994; Nuhoglu et al., 2003; Sherrill et al., 1992), especially to those children whose mothers smoked during pregnancy (Rizzi et al., 2004), and who were exposed to passive smoking during the first five years of life (Wang et al., 1994). Moreover, it is supposed, although not extensively studied, that physical exercise and sport activity positively influence PF in youngsters (Courteix, Obert, Lecoq, Guenon, & Koch, 1997; Goic-Barisic et al., 2006; Nourry et al., 2004). Some authors (Courteix et al., 1997; Nourry et al., 2004) showed a significant improvement in PF of active young athletes in longitudinal studies, and others (Goic-Barisic et al., 2006) identified significant differences in PF between exercised and non-exercised children. However, there are evident disagreements about the possible factors which lead to the dominance of exercised children in the PF variables, in comparison to the non-exercised controls. More precisely, there is no firm evidence that physical training improves PF in humans. However, most of these studies might suffer from sport-selection effects and, therefore, the statistical suppressor effect. Finally, studies investigating the influence of passive smoking and sports training on the PF in children are scarce. Therefore, in this article, we analysed the PF status of prepubescent athletes (basketball players and dinghy sailors) and non-athletes, and studied the possible influence of passive smoking status on their PF.

Accepted after revision: September 18 2016 | First published online: March 01 2017

Conflict of interest: None declared.

We were of the opinion that dinghy sailing (one person sailing in small boats; e.g. Optimist and Cadet sailing class), and basketball are interesting for the purpose of studying PF because of the following: (a) sailing is performed in the open air and sea, which can lead to certain advantages regarding respiratory function (clean and fresh air, aerosols, etc.), but also risks (cold and wind exposure for example); (b) sailing is mostly static and characterized by static muscle contractions, while basketball is a dynamic sport. The difference in dynamics leads to obvious differences in oxygen uptake for those two sports; less than 40 and more than 50 ml/kg/min for sailing and basketball, respectively (Apostolidis, Nassis, Bolatoglou, & Geladas, 2006; Sekulic, Medved, Rausavljevi, & Medved, 2006). Therefore, we presumed the possible differential effects in the PF of the two sports studied.

Methods

The sample consisted of 75 subjects in total (age 11.3±2 months), divided into two experimental groups (E) and one control group (C; N = 25). The first E group consisted of young dinghy sailors (ES; N = 23), and the second one of young basketball players (EB; N = 27). The C group consisted of boys who were not engaged in any organized sports activity apart from PE. None of the examinees reported any recent health problems and any respiratory diseases. For all the subjects at least one parent was informed about the purpose of the study, giving their informed consent.

PF testing was performed using the Jaeger MasterLab (Erich Jaeger GmbH & CoKG, Wűrzburg, Germany) (Sekulic & Tocilj, 2006; Goic-Barisic et al., 2006; Peric at al., 2014). The same person performed all the tests on the subjects. All the subjects were given standardized instructions on the forced maximal expiratory manoeuvres with a demonstration of the procedures. The tests were performed with the subjects sitting, breathing through a mouthpiece with a nose clip. The spirometer was calibrated by means of two syringes using the instrument's automatic calibration programme. Parameters derived from the flow-volume curves were: inspiratory vital capacity (VCIN) forced vital capacity (FVC), forced expiratory volume in one second (FEV1), peak expiratory flow (PEF), maximal expiratory flow at 50% and 75% exhalation (MEF50 and MEF25). Since the previous studies dealt with two sets of pulmonary variables (Sekulic & Tocilj, 2006), the VCIN, FVC, FEV1 are used to describe the airway obstruction in the large airways (large airways variables (LAV)), whereas PEF, MMEF, and MEF values were used to describe the airway obstruction in the small airways (small airways variables (SAV)).

Apart from PF, body height (BH) and body weight (BW), and skinfold variables were measured which allowed us to calculate body fat percent (BF%) according to the Siri equation (Elberg et al., 2004).

None of the examinees was an active smoker. The passive smoking status was identified using a simple questionnaire consisting of two questions: 1) Is anyone in your household a smoker? (If no) 2) Has anyone of your household quit smoking? When the first question was answered positively, we considered the subject to be a passive smoker (PS). If both questions were answered negatively, we considered the subject to be not exposed to passive smoking (NS). Finally, if only the second question were answered positively, we excluded the subject from the study. The passive smoking status was also verified by one parent. If the parent's result on the questionnaire was in disagreement with the subject's result on the questionnaire, the subject was not included in the study. Accordingly, based on both criteria, the drop-out in the E groups was about 7% (4 subjects). The questionnaire was found to be highly reliable per Spearman's correlation coefficient (0.92) calculated for the test-retest on the questionnaire.

For all the variables, we calculated the descriptive statistics. The student's T-test for the independent (non-correlated samples) was applied to determine the significance of the differences between the groups in anthropometric variables (BH, BW, and BF%). Additionally, the multivariate analysis of the variance (MANOVA) was applied for the purpose of the multivariate comparison of SAV and LAV separately between the different groups of subjects. We calculated MANOVA differences for LAV and SAV within EB, ES, and C regarding the smoking status, and between EB, ES, and C (separately for PS and NS). Factor analysis was used to determine the factor structure and character of the relationships between variables. All the coefficients were considered significant at a level of 0.95 ($p<0.05$). All the calculations were performed using Statsoft's Statistica, version 6.0.

Results

The EB are the tallest of all subjects and, when compared to ES, dominant in BW. The EB and ES do not significantly differ in BF%, while the highest values of the BW and BF% are found in C group (all presented in Table 1).

TABLE 1 Descriptive statistics (Mean±SD) and t- test significance

	Total	Sailing (ES)	Basketball (EB)	Control (C)
BH (cm)	155.41 ± 8.13	152.09 ± 8.12	159.52 ± 9.99 [a]	154.54 ± 6.32
BW (kg)	47.04 ± 10.09	40.36 ± 6.41	45.29 ± 8.12 [a]	53.55 ± 12.11 [a,b]
BF% (%)	19.61 ± 8.22	14.78 ± 3.21	16.33 ± 5.21	25.89 ± 8.61 [a,b]

Legend: BH - body height; BW - body weight; BF% - percent of the body fat; [a] significantly different from ES; [b] significantly different from EB

UDC 796.011.1:613.84-053.6

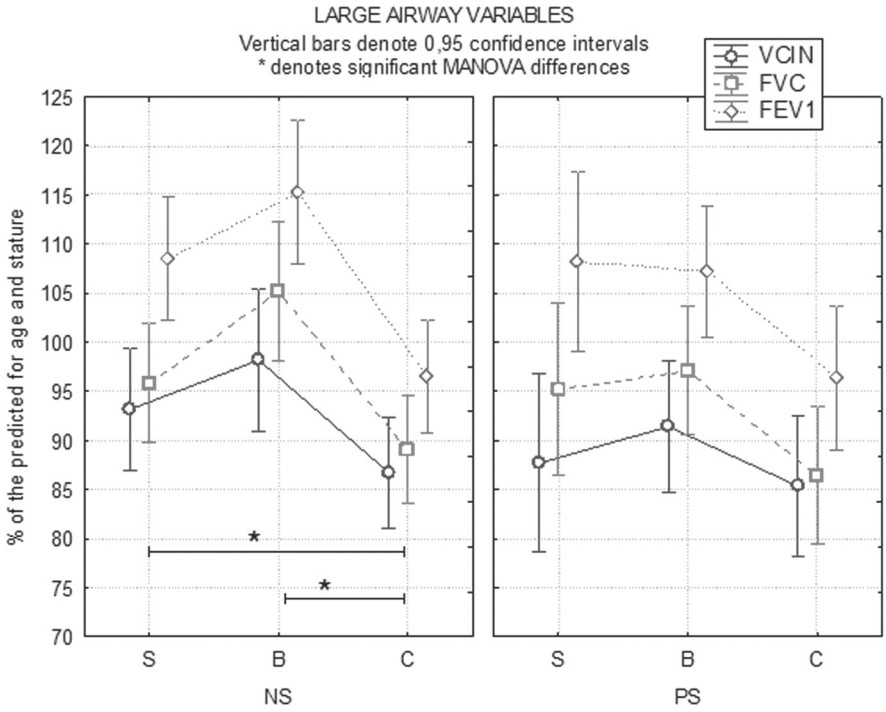


FIGURE 1 Relative values of the large airway variables (mean ± SEM) and multivariate analysis of the variance significance when comparing young sailors (S), young basketball players (B), and control (C), separately in the non-exposed to passive smoking (NS) and passive smokers (PS). VCIN - inspiratory vital capacity, FVC - forced vital capacity, FEV1 - forced expiratory volume in one second, PEF - peak expiratory flow, MEF50 - maximal expiratory flow after 50% exhalation, MEF25 - maximal expiratory flow after 75% exhalation

In Figures 1 and 2, relative LAV and SAV parameters are presented and statistically compared between the groups, separately for PS and NS. Within the NS sub-sample, EB and ES significantly dominate in the relative LAV and SAV values, in comparison to C. In the PS sub-sample, the groups do not differ significantly in LAV, or in SAV.

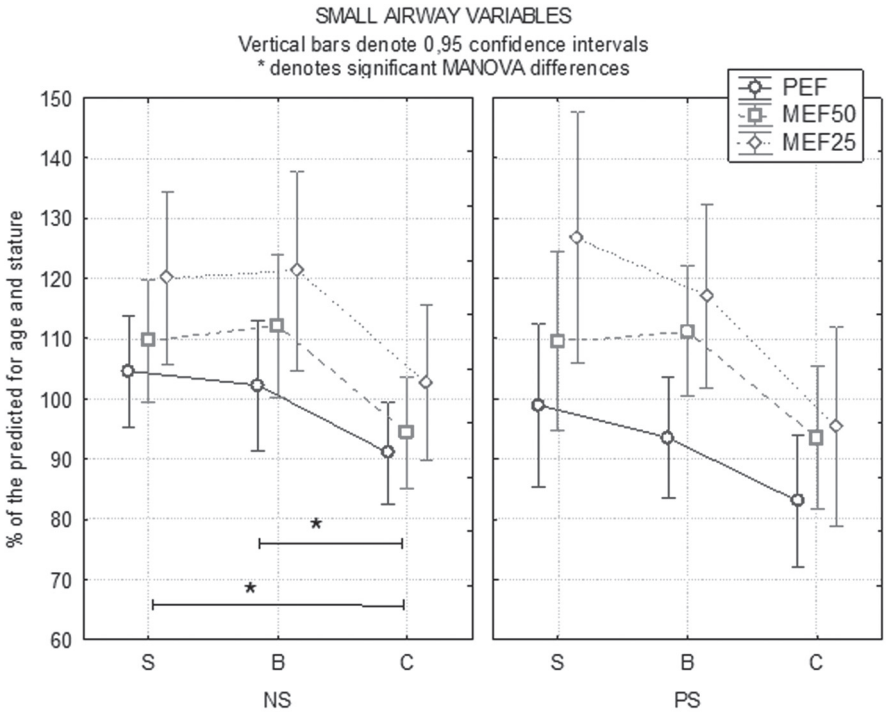


FIGURE 2 Relative values of the small airway variables (mean ± SEM) and multivariate analysis of the variance significance when comparing young sailors (S), young basketball players (B), and control (C), separately in the non-exposed to passive smoking (NS) and passive smokers (PS). VCIN - inspiratory vital capacity, FVC - forced vital capacity, FEV1 - forced expiratory volume in one second, PEF - peak expiratory flow, MEF50 - maximal expiratory flow after 50% exhalation, MEF25 - maximal expiratory flow after 75% exhalation

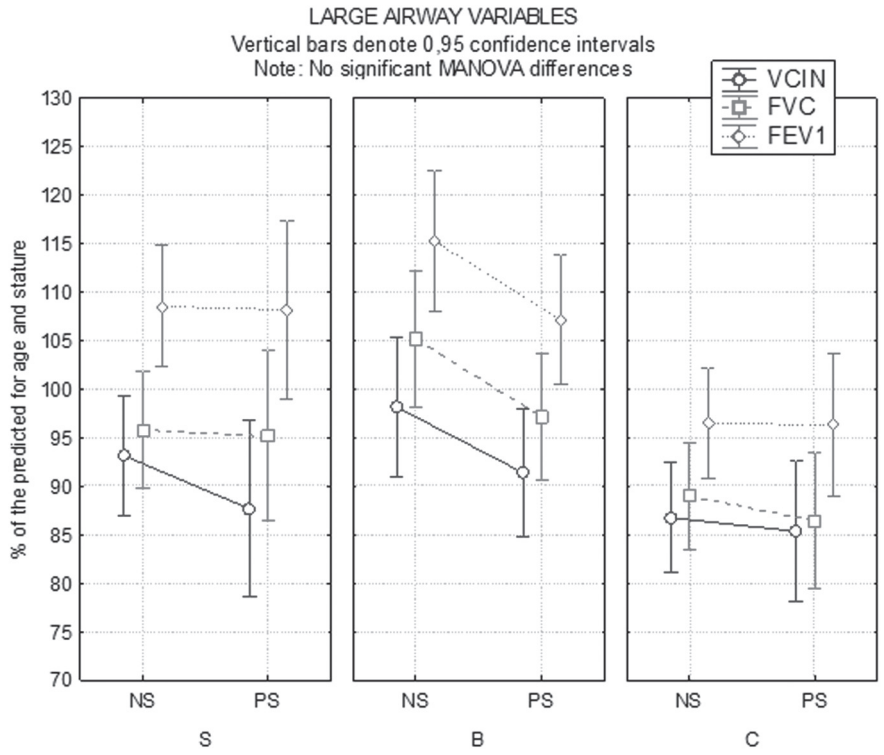


FIGURE 3 Relative values of the large airway variables (mean ± SEM) and multivariate analysis of the variance significance when comparing NS (non-exposed to passive smoking) and PS (passive smokers) in the young sailors (S), young basketball players (B), and control (C). VCIN - inspiratory vital capacity, FVC - forced vital capacity, FEV1 - forced expiratory volume in one second

When comparing PS and NS within the different groups of subjects, we found no significant differences between PS and NS in LAV (Figure 3), or in SAV (Figure 4).

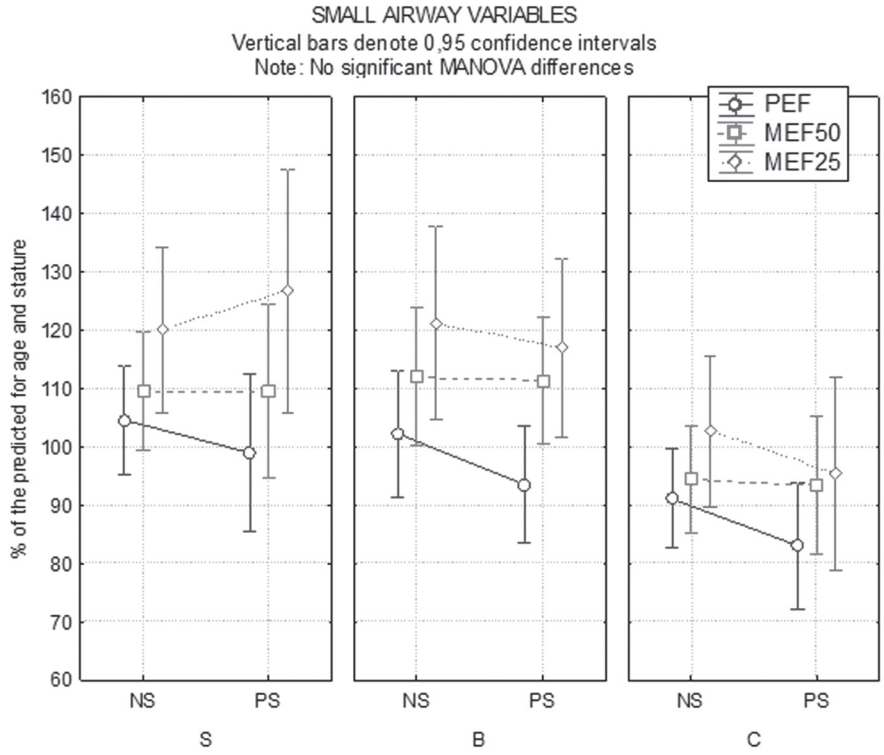


FIGURE 4 Relative values of the small airway variables (mean ± SEM) and multivariate analysis of the variance significance when comparing NS (non-exposed to passive smoking) and PS (passive smokers) in the in the young sailors (S), young basketball players (B), and control (C). PEF - peak expiratory flow, MEF50 - maximal expiratory flow after 50% exhalation, MEF25 - maximal expiratory flow after 75% exhalation

UDC 796.011.1:613.84-053.6

Discussion

The EB dominance in BH was expected since boys who chose to participate in basketball sports training were significantly taller than others even two years before our experiment (see Table 1). Differences in BF% in which E groups were significantly lower in values than C were also expected. Briefly, the previous studies regularly found that additional physical activity (e.g. sports activity) in pre-pubertal boys leads to more systematic changes in the anthropometric status, when compared to less physically active peers, mostly observable in skinfold and BF measures (Dowda, Ainsworth, Addy, Saunders, & Riner, 2001; Mukhopadhyay, Bhadra, & Bose, 2005; Sekulic, Krstulovic, Katic, & Ostojic, 2006). We found that the groups did not differ significantly in BW, nor triceps skinfold (e.g. body fat). The only difference was found in BH, where EB where significantly taller than ES (see previous text).

Observations and discussion regarding PF are divided into the next paragraphs.

Pulmonary function in prepubescent athletes and non-athletes

The problem of a possible positive influence of physical activity on PF persists. In some prior studies (Zinman & Gaultier, 1987) authors concluded that lung volumes in young athletes (swimmers) could not be accounted for by an increased ability to inflate and deflate the lungs by the respiratory muscles. However, in a more recent study (Courteix et al., 1997), the authors were of the opinion that physical training directly stimulates lung growth by harmonizing the development of the airways and alveolar lung spaces. Since we found the significant dominance of the ES and EB in LAV and SAV variables when comparing them to the less physically active controls, the data presented herein support the idea of a positive influence of physical exercise on the PF in children. However, there are no significant differences between the ES and EB in any of the analysed set of variables. We are of the opinion that two possible explanations have to be indicated for such a condition. First, there is a possibility that two years of active sport participation at such an age (from 9 to 11 years of age) is a relatively short period for any significant differential effects of the two different sports (in our case, sailing and basketball) on the PF in young athletes. It is especially apparent if we observe the numerical (although not significant) dominance of the EB in comparison to ES in most of the LAV (Figure 3). Hence, it is possible that the dynamic character of the basketball game, and the higher oxygen consumption, assure a more generative basis for the PF development, mostly by encouraging larger respiratory excursions. There are some opinions that it can result in a larger ventilatory or total lung capacities without necessarily reflecting more or larger alveoli (Merkus, Ten Have-Opbroek, & Quanjer, 1996). It seems logical that such changes are more observable in LAV than in SAV, where no observable numerical differences can be found between ES and EB (Figure 3). Another option for the nonsignificant differences in PF between ES and EB can be found in the system of the calculation of the relative PF values. Briefly, young basketball players are in the tallest two percentiles for 11-year-old boys (Malina, Bouchard, & Bar-Or, 2004). Next, the relative parameters of the PF herein are calculated using the linear function of the BH and age (Knudson, Slatin Rc, Lebowitz, & Burrows, 1976). Such equations presume a linear increase of the PF variables with an increase of the BH, since lung volume, which naturally follows an increase of body proportions, is mostly defined by an increase of the BH. However, when the graphical presentations of the relationships between BH and PF are observed (see for example Boskabady, Tashakory, Mazloom, & Ghamami (2004), it is clear that the relationship is nonlinear. The linear calculation of the relative PF values practically penalizes persons whom are significantly taller than average (in our case, young basketball players), mostly because the body proportions in very tall subjects is not followed by proportional increases in other body proportions (diameters of the chest, for example). It is indirectly supported by numerous studies which introduced and studied the different allometric (nonlinear) calculations in human performance (Hoff, Kemi, & Helgerud, 2005; Markovic & Jaric, 2004; Sekulic, Zenic, & Markovic, 2005).

The significance of the differences in LAV, which was previously discussed, exists in SAV, where the E groups achieved significantly better results than the controls. However, the numerical differences between the two E groups previously noted in LAV variables are not so pronounced in SAV variables.

Nevertheless, all the differences we discussed so far are significant exclusively in the sub-sample of subjects who were not exposed to tobacco smoke (NS). More precisely, when comparing the passive smokers of the three groups (ES, EB, and C), we found no significant differences in PF. We will try to identify the possible reasons in the following text.

Pulmonary function in prepubescent passive smokers and non-exposed to passive smoking

According to the presented data, and MANOVA calculations, passive smoking does not significantly influence PF in prepubescent boys. However, it cannot be ignored that the pulmonary variables of the PS subjects are regularly numerically (although not significantly) lower than NS subjects in all the three groups of subjects (ES, EB, and C). The nonsignificant differences in LAV and SAV status of PS, when compared to NS, are not unidentified so far. Although most of the previous studies reported a negative influence of passive smoking on the PF of the subjects (Cook, Strachan, & Carey, 1998), it is not rare to find studies in which a negative influence was not established, and/or the differences did not reach any appropriate level of statistical significance (Bek, Tomac, Delibas, Tuna, & Tezic, 1999), while others found a dose-effect relationship (Rizzi et al., 2004). Since most of the PF values were lower in PS, it seems reasonable to expect that after an extended length of time of exposure to passive smoking the differences between PS and NS will increase, and therefore

will be significant in the future. Such a conclusion can be supported by previous studies in which the significant negative influence of passive smoking was regularly established when studying somewhat older children than those in our experiment (16 and 14 years in average) (Goic-Barisic et al., 2006; Rizzi et al., 2004). Another factor should be noted when explaining the nonsignificant differences between PS and NS in the studied samples of subjects in this paper. In 2006, Sekulic and Tocilj observed a non-systematic relationship in LAV and SAV for PS, when compared to NS. Briefly, the variables of the PF (LAV and SAV separately) are strongly correlated in NS exclusively, although those variables practically measure the same status and are influenced by the same processes. In explaining the relatively low correlation between PF variables in smokers, Sekulic and Tocilj (2006) presumed that passive smoking non-systematically negatively affects PF, defining the low correlation between the variables which should be systematically highly correlated. The mechanism of such a non-systematic influence of passive smoking remains unclear, but it is supposed that it depends on several factors including (1) dose-effects, (2) duration of the exposure to tobacco smoke, (3) artificially stimulated and shortened breathing in smokers, and/or (4) physical exercise. The first two mentioned factors are supposed to influence PF negatively, and the last two influence positively and partially diminish the negative effects of passive smoking on the PF. Following that idea, we additionally performed a factor analysis trying to establish the possible differences in the relationships between PF variables in PS, and NS. If such differences in the relationships exist in this studied sample of subjects (children), it will be a strong support to the previously discussed, since studies that suggested the problem of the non-systematic influence of the passive smoking were performed on adults.

TABLE 2 Factor analysis for the pulmonary function variables

	PS		NS	
	F1	**F2**	**F1**	**F2**
VCIN	0.97	0.02	0.95	0.2
FVC	0.97	0.07	0.95	0.21
FEV1	0.89	0.37	0.83	0.48
PEF	0.71	0.44	0.33	0.74
MEF50	0.27	0.90	0.20	0.93
MEF25	0.05	0.96	0.20	0.85
Expl.Var	3.25	2.05	2.68	2.45
Prp.Totl	0.54	0.34	0.45	0.41

Legend: PS - passive smokers, NS – non-exposed to passive smoking, VCIN - inspiratory vital capacity, FVC - forced vital capacity, FEV1 - forced expiratory volume in one second, PEF - peak expiratory flow, MEF50 - maximal expiratory flow after 50% exhalation, MEF25 - maximal expiratory flow after 75% exhalation; Expl.Var. - Variance explained, Prp.Totl. - Proportion of the total variance explained, F1 and F2 – factor structure

The results in Table 2 leave no doubt regarding the more coherent factor structure in the NS than in PS. Moreover, in the PS the PEF is projected on the F1 factor of the large airways function. In the NS sample, two very clear and easily interpretable factors are extracted, the F1 factor of the large airways function and the F2 factor of the small airways function. Since the factor analysis is elementary based on the correlation which exists between the different variables (Sekulic, Viskic-Stalec, & Rausavljevic, 2003) it is clear that conclusions from the previous studies regarding the non-systematic negative effect of passive smoking on the PF are supported herein. There is one more thing to support all that is said, and it relates to the variability of the results in the PS. It is clear that all the variables in the PS are more dispersed in comparison to the same variables in the NS subjects. Since the variability of the results determines the possibility of reaching the appropriate statistical significance of the differences (in our case, the significance of the differences between PS and NS), it is one more reason why we did not find any significant difference between PS and NS in any of the PF variables, although numerical differences of means are observable in most cases.

Conclusions

The results of this study indicated significantly higher values of LAV and SAV in young athletes when compared to age-related controls, indicating a possible positive influence of physical exercise on the PF, affirming the first hypothesis of our study. It seems that the dynamic character of the basketball game has no differential effect on the PF when compared to the static character of dinghy sailing. Therefore, the second hypothesis of our study, in which we assumed more positive influence on the basketball game on the PF in boys, cannot be confirmed. Herein, we did not find any significant differences between passive smokers and examinees non-exposed to passive smoking in PF, probably because of the high variability of the results which did not allow reaching the acceptable level of significance. Moreover, we studied young children (11 years of age), while significant differences in the PF status between passive smokers and examinees non-exposed to passive smoking was previously regularly found for older children. Consequently, the third hypothesis of our study has to be rejected.

UDC 796.011.1:613.84-053.6

There is certain evidence that the calculation of the relative PF values in children penalizes tall subjects, and should be revalidated. Further studies should define the longitudinal influence of sports training on the PF while precisely controlling sports selection and its influence on the PF results.

Acknowledgement

The authors gratefully acknowledge the support and help of Ms Ana Erceg and Ms Milena Marovic from the Pulmonary Division of the Clinical Hospital Split.

REFERENCES

Apostolidis, N., Nassis, G. P., Bolatoglou, T., & Geladas, N. D. (2006). Physiological and technical characteristics of elite young basketball players. *Journal of Sports Medicine and Physical Fitness, 44*(2), 157-163.

Bek, K., Tomac, N., Delibas, A., Tuna, F., & Tezic, H. T. (1999). The effect of passive smoking on pulmonary function during childhood. *Postgraduate Medical Journal, 75*(884), 339-341.

Boskabady, M. H., Tashakory, A., Mazloom, R., & Ghamami, G. (2004). Prediction equations for pulmonary function values in healthy young Iranians aged 8–18 years. *Respirology, 9*(4), 535-542.

Cook, D. G., Strachan, D. P., & Carey, I. M. (1998). Parental smoking and spirometric indices in children. *Thorax, 53*(10), 884-893.

Courteix, D., Obert, T., Lecoq, A. M., Guenon, P., & Koch, G. (1997). Effect of intensive swimming training on lung volumes, airway resistances and on the maximal expiratory flow-volume relationship in prepubertal girls. *European Journal of Applied Physiology and Occupational Physiology, 76*(3), 264–269.

Dowda, M., Ainsworth, B. E., Addy, C. L., Saunders, R., & Riner, W. (2001). Environmental Influences, Physical Activity, and Weight Status in 8- to 16-Year-Olds. *Arch Pediatr Adolesc Med., 155*(6), 711-717.

Elberg, J., Mcduffie, J. R., Sebring, N. G., Salaita, C., Keil, M., Robotham, D., . . . Yanovski, J. A. (2004). Comparison of methods to assess change in children's body composition. *The American Journal of Clinical Nutrition, 80*(1), 64-69.

Goic-Barisic, I., Bradaric, A., Erceg, M., Barisic, I., Foretic, N., Pavlov, N., & Tocilj, J. (2006). Influence of passive smoking on basic anthropometric characteristics and respiratory function in young athletes. *Collegium Antropologicum, 30*(3), 615–619.

Haby, M. M., Peat, J. K., & Woolcock, A. J. (1994). Effect of passive smoking, asthma, and respiratory infection on lung function in Australian children. *Pediatric pulmonology, 18*(5), 323–329.

Hoff, J., Kemi, O. J., & Helgerud, J. (2005). Strength and Endurance Differences Between Elite and Junior Elite Ice Hockey Players. The Importance of Allometric Scaling. *International Journal of Sports Medicine, 26*(7), 537-541.

Knudson, R. J., Slatin Rc, R. C., Lebowitz, M. D., & Burrows, B. (1976). The Maximal Expiratory Flow-Volume Curve. *American Review of Respiratory Disease, 113*(5), 587-600.

Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity* (Second ed.): Human Kinetics.

Markovic, G., & Jaric, S. (2004). Movement performance and body size: the relationship for different groups of tests. *European Journal of Applied Physiology, 92*(1), 139–149.

Merkus, P. J., Ten Have-Opbroek, A. A., & Quanjer, P. H. (1996). Human lung growth: A review. *Pediatric pulmonology, 21*(6), 383–397.

Mukhopadhyay, A., Bhadra, M., & Bose, K. (2005). Anthropometric Assessment of Nutritional Status of Adolescents of Kolkata, West Bengal. *Journal of Human Ecology, 18*(3), 213-216.

Nourry, C., Deruelle, F., Guinhouya, C., Baquet, G., Fabre, C., Bart, F., . . . Mucci, P. (2004). High-intensity intermittent running training improves pulmonary function and alters exercise breathing pattern in children. *European Journal of Applied Physiology, 95*(4), 415-423.

Nuhoglu, C., Gurul, M., Nuhoglu, Y., Karatoprak, N., Sonmez, E. O., Yavrucu, S., & Ozguner, A. (2003). Effects of passive smoking on lung function in children. *Pediatrics International, 45*(4), 426–428.

Peric, M., Cavar, M., Zenic, N., Sekulic, D., & Sajber, D. (2014). Predictors of competitive achievement among pubescent synchronized swimmers: an analysis of the solo-figure competition. *Journal of Sports Medicine and Physical Fitness*, 54(1) 16-26.

Rizzi, M., Sergi, M., Andreoli, A., Pecis, M., Bruschi, C., & Fanfulla, F. (2004). Environmental tobacco smoke may induce early lung damage in healthy male adolescents. *Chest, 125*(4), 1387-1393.

Sekulic, D., Krstulovic, S., Katic, R., & Ostojic, L. (2006). Judo Training is More Effective for Fitness Development Than Recreational Sports for 7-Year-Old Boys. *Pediatric Exercise Science, 18*, 329-338.

Sekulic, D., Medved, V., Rausavljevi, N., & Medved, V. (2006). EMG analysis of muscle load during simulation of characteristic postures in dinghy sailing. *Journal of Sports Medicine and Physical Fitness, 40*, 20-27.

Sekulic, D., & Tocilj, J. (2006). Pulmonary Function in Military Divers: Smoking Habits and Physical Fitness Training Influence. *Military Medicine, 171*(11), 1171-1175.

Sekulic, D., Viskic-Stalec, N., & Rausavljevic, N. (2003). Non-linear relations between selected anthropological predictors and psycho-physiological exercise-responses. *Collegium Antropologicum, 27*(2), 587–598.

Sekulic, D., Zenic, N., & Markovic, G. (2005). Non Linear Relationships between Anthropometric and Motor-Endurance Variables. *Collegium Antropologicum, 29*(2), 723-730.

Sherrill, D. L., Martinez, F. D., Lebowitz, M. D., Holdaway, M. D., Flannery, E. M., Herbison, G. P., . . . Sears, M. R. (1992). Longitudinal Effects of Passive Smoking on Pulmonary Function in New Zealand Children. *American Review of Respiratory Disease, 145*(5), 1136-1141.

Wang, X., Wypij, D., Gold, D. R., Speizer, F. E., Ware, J. H., Ferris Jr, B. G., & Dockery, D. W. (1994). A longitudinal study of the effects of parental smoking on pulmonary function in children 6-18 years. *American Journal of Respiratory and Critical Care Medicine, 149*(6), 1420-1425.

Zinman, R., & Gaultier, C. (1987). Maximal static pressures and lung volumes in young female swimmers: One year follow-up. *Pediatric pulmonology, 3*(3), 145–148.

UDC 796.011.1:613.84-053.6

ORIGINAL SCIENTIFIC PAPER

Reliability and Validity of the Turkish Language Version of the Test of Performance Strategies

Miçooğulları Bülent Okan[1]

Affiliations: [1]University of Nevşehir Hacı Bektaş Veli, Faculty of Education, Department of Physical Education and Sport Education, Nevşehir, Turkey

Correspondence: Miçooğulları Bülent Okan, University of Nevşehir Hacı Bektaş Veli, Faculty of Education, Prof. İlhan Varank Avenue, Kayseri Yolu, 50300 Nevşehir, Turkey. E-mail: omicoogullari@nevsehir.edu.tr

ABSTRACT The aim of the present study was to examine the psychometric properties of the Test of Performance Strategies (TOPS; Thomas et al., 1999) on the Turkish population. The TOPS was designed to assess eight psychological skills and strategies used by athletes in competition (activation, automaticity, emotional control, goal-setting, imagery, relaxation, self-talk, and negative thinking) and the same strategies, except negative thinking is replaced by attentional control used in training. The sample of the study included athletes who were training and competing in a wide variety of sports across a broad range of performance standards. The final sample consisted of 433 males (mean ± s: age 22.47 ± 5.30 years) and 187 females (mean ± s: age 20.97 ± 4.78 years), 620 athletes in total (mean ± s: age 21.25 ± 4.87 years) who voluntarily participated; TOPS was administered to all participants. Afterward, Confirmatory Factor Analysis (CFA) was conducted by Analysis Moments of Structures (AMOS) 18. Comparative fit index (CFI), non-normed fit index (NNFI) and root mean square error of approximation (RMSEA) were used to verify whether the model fit the data. Goodness-of-fit statistics were CFI= .91, NNFI= .92 and RMSEA= .056. These values showed that the tested model is coherent at a satisfactory level. Moreover, results of confirmatory factor analyses revealed that a total of four items (two items from competition and two from practice) within the subscale of automaticity have been removed. The 28 items within the remaining seven subscales have been validated. In conclusion, Turkish version of TOPS is a valid and reliable instrument to assess the psychological skills and strategies used by athletes in competition and practices.

KEY WORDS Psychological Strategies, Psychological Skills, Confirmatory Factor Analysis.

@MJSSMontenegro
LANGUAGE VERSION OF TEST OF PERFORMANCE STRATEGIES
http://mjssm.me/?sekcija=article&artid=134

Introduction

Research results have indicated that sport as a concept is nested with several disciplines, one of which is psychology. Research on psychology has shown that the time allocated to the psychological skills should be comparable to that allocated to physiological skills.

Psychological skills used in a sport environment, such as goal setting, imagery, concentration, emotional control, relaxation, etc., are helpful to athletes in reaching their training and competition goals and can be learned (Ritz, 2012; Malouff, 2008). All psychological skills have been confirmed to characterize successful and unsuccessful athletes (Katsikas, Argeitaki & Smirniotou, 2009). Due to the decisive role of psychological skills, along with training and competition techniques, it is evident that its effect on the performance of the athletes in the world is crucial.

Speaking broadly, the process of teaching the psychological skills used in sports is called psychological skill training. A more detailed description of practices includes combinations of individual or group work to attain psychological skill needs of athletes. These combinations of skills are for research and training purposes in general, and the skills specified in the training program are all inter-linked (Weinburg & Gould, 2007; Sindik, Botica & Fiskus, 2015).

Accepted after revision: November 25 2016 | First published online: March 01 2017

Conflict of interest: None declared.

Many scientific research studies have indicated the contribution of psychological skill training in the performance and daily lives of the athletes in many social-psychological parameters (Tenenbaum & Eklund, 2007). One common way to test the effectiveness and efficacy of the psychological skill training on athletes is to identify psychological performance strategies used in psychological processes encountered in training and competitions. Sports psychologists aim to identify the strengths and weaknesses of athletes using the psychological assessment of athletes.

The efforts to identify the athletes' psychological performance strategies in a scientific context began with the Psychological Performance Scale (PPS), developed by Loehr in 1986. This scale was developed to improve the athletes' capacity to understand mental skills and their perceptions of those skills. The Psychological Performance Scale includes the sub-dimensions confidence, negative energy, attention control, visual and imagery control, motivation level, positive energy and attitude control. To determine the validity and reliability of the scale, a number of research studies have been conducted, the results of which were inconsistent with each other (Thomas, Murphy & Hardy, 1999). Consequently, PPS has not been used much as research parameters in psychological applications.

Later, Mahoney et al. (1987) developed the Psychological Skill in Sports scale, which has been used in several studies. It consists of 51 true-false questions that aim to determine and evaluate the psychological skills related to the performance of successful athletes. It was revised to a newer version with 45 items and six sub-sections with the performed statistical analysis in the development process of the scale. These are anxiety control, trust, concentration, motivation, team integrity, and mental preparation. The scale (scored with 5-point Likert) was successful in determining and classifying gender differences (White, 1993). However, researchers interested in the topic encountered some significant statistical problems, such as very low alpha coefficients (Chartrand et al., 1992), invalid factor structure (Tammen & Murphy, 1990), and confirmatory factor analysis results.

Another scale to determine strategies for using psychological skills is Athletic Coping Skills. The development process of this scale began in 1990, and the latest version was reached in 1995. The ACS started with 42 questions and eight sub-dimensions and then evolved to a version with seven sub-dimensions and 28 questions. The scale, which aims to examine the psychological skills used in the process of performance stabilization and development, has sub-dimensions including coping with adversity, goal setting/mental preparation, concentration, confidence and achievement motivation, coachability, freedom from worry, and ability to cope with difficulties (Smith & Christensen, 1995). The scale has the best statistical results regarding validity and reliability to date. The first significant problem with this scale was that confirmatory factor analysis and exploratory factor analysis was performed on the same participants. The second important critique was that even the scale comprises all the psychological skills in general, it only investigates stress management and its limited skills.

After all the scales mentioned above and their positive and negative points, Performance Strategies scale was developed by Thomas et al. in 1999. The critiques of the other methods disregarded the psychological processes the athletes go through while preparing for competitions and usage of psychological skills in competitions. According to Thomas et al., the psychological skills and their usage strategies are parts of the training process and this process has always been neglected. When an athlete in any branch is considered, he/she spends 90% percent of his/her sports time in training, which supports the significance of the previous statement (McCann, 1995).

In light of that information, Thomas et al. developed the scale that aims to determine the ratio of the psychological skill usage and ability with the aid of questions (which were answered by 472 athletes) specific to competition and training environments. Participating athletes who were training and competing from a broad range of different sports and categories created heterogeneity that revealed broad applicability across a wide variety of performance levels and ages (Lane et al., 2004). The ability to evaluate psychological strategies within the practice and its strong statistical infrastructure has caused it to become a recommended instrument to assess psychological strategies within the sport environment (Katsikus, 2011).

Because of its critical power, all responsible staff (athletes, coaches, sport psychologists) in the sport environment have accepted it as a valid and reliable instrument for evaluating psychological skills and strategies. Moreover, the TOPS has been approved as a research tool to evaluate the effectiveness of interventions to improve mental skills and to determine proper psychological skills for intact athletes in various countries. The first process of this type of adaptation studies was confirmatory factor analysis (CFA). Items of subscales and sub-domains can be understood differently within different communities, and one of the best ways is using CFA to verify the validity and reliability values of test models to confirm that the questionnaire used (TOPS) is a reliable instrument. In light of all the above information, the aim of the present study was to assess the psychometric properties of TOPS on the Turkish population.

Methods

This is a scale adaptation study. Within its context, the preliminary application of the scale that was tested its Turkish equivalence by experts, after that validity and reliability procedures have been practiced to the obtained data.

UDC 796.2:159.98(560)

Participants

The sample of the study consisted of 433 males (22.47 ± 5.30 years) and 187 females (20.97 ± 4.78 years); in total, 620 athletes (mean ± s: age 21.25 ± 4.87 years) volunteered to participate the current study. Those athletes were training and competing in a broad variety of sports and had different levels of competition experience. The participants were chosen from 17 different sports, including soccer, basketball, volleyball, handball, track and field, tennis, and swimming.

Measuring Instrument

The TOPS (Thomas et al., 1999) was used to evaluate the psychological skills used by athletes in various situations, including competition and practice. As described earlier, the TOPS is a 64-item instrument assessing 16 psychological skills in both practice and competition. All questions require that the participant respond to a five-point Likert-type frequency scale, with "1" meaning never and "5" always. The subscales of TOPS, their definitions, and example items are displayed in Table 1.

TABLE 1 All subscales of TOPS, their definitions, and example items.

Subscales	Definition	Example Item for Competition	Example Item for Practice
Goal Setting	Setting performance- and outcome-related goals or objectives	I set very specific goals	I set realistic but challenging goals for practice
Imagery	Visualizing sport movements prior to actual performance	I imagine a competitive routine before I do it	I rehearse my performance in my mind
Activation	Controlling an optimal arousal specific to the demands of the mission	I raise my energy level when necessary	I practice energizing during training sessions
Self-talk	Carrying on positive internal dialogue	I have specific cue words or phrases that I say to myself to help my performance during competition	I motivate myself to train through positive talk
Emotional Control	Control over athlete's emotions during tough situations	My emotions get out of control under the pressure of competition	When I perform poorly, I lose my focus in training
Automaticity	Occurring skills without conscious thought	I perform at competitions without consciously thinking about it	During practice sessions, seems to be in a flow
Relaxation	Applying strategies to remain calm before a challenge	I am able to relax if I get too nervous	Practice using relaxation techniques at workouts
Negative Thinking (competition only)	Entertaining thoughts of failure	I am able to keep my thoughts positive	
Attentional Control (practice only)	Focusing attention effectively		I am able to control distracting thoughts when training

Translation and Turkish-English Equivalency of the Scale

The Test of Performance Strategies survey was translated into Turkish by the author with the supervision of two experts in the English language. Afterward, the items of the instrument were examined by two Turkish language expert academics and one physical education and sport education academic who made an evaluation of the construction of the scale. Corrections were made according to these views.

Following the views and suggestions of the three experts, the initial form of the instrument was established. After that, items of the Turkish form of the instrument were translated into English by two bilinguals to compare the Turkish-English equivalency of the scale by item-by-item back-translation. Finally, an item-by-item comparison of the results revealed that the two forms are identical in terms of the items' meaning. These findings prove that the Turkish and English versions of the instruments can be regarded as being equivalent.

Statistical Analysis

Confirmatory Factor Analysis (CFA) was conducted by Analysis Moments of Structures (AMOS 18). Comparative fit index (CFI), non-normed fit index (NNFI) and root mean square error of approximation (RMSEA) were used to check if the model fit the data. Cronbach's Coefficient Alpha was computed to check for the internal consistency of adapted scale. The following Threshold Levels were used in order to prove model fits (Öcal, 2011).

TABLE 2 Fit Indices and Their Acceptable Threshold Levels

Fit Index	Acceptable Threshold Levels
Chi Square/df	$\chi^2 / df < 5$ (Wheaton et al, 1977)
CFI	CFI>0.90, acceptable (Maruyama, 1998)
NNFI(TLI)	NNFI>0.90 acceptable (Maruyama, 1998)
RMSEA	RMSEA<0.08, adequate model fit (Jaccard & Wan, 1996)

Results

Because the TOPS has two different sub-dimensions (Competition & Practice strategies) used together, the results of the analysis are given as separate subheadings for those sub-dimensions.

CFA Analysis of Competition Strategies Sub-dimension

CFA was used in order to test the factor structure that shows the Competition strategies sub-dimension of the Test of Performance Strategies over the data gathered from athletes. Firstly, for a model with eight factors (activation, automaticity, emotional control, goal-setting, imagery, relaxation, self-talk, and negative thinking) set in the original sub-dimension, goodness of fit (GOF) statistics were calculated. As a result of the analysis, $\chi 2$ (df=341, p=.00)=1520.01, $\chi 2$ 152/ df =4.46, RMSEA (Root Mean Square Error of Approximation)=.161, CFI (Comparative Fit Index)=0.86, NNFI (Non-Normed Fit Index)=0.85 indicated that the model was not fit with the expected level. Concerning these results, it was detected that two items' factor loading were low in their own factor, two items from automaticity subscale for competition strategies (item 30 (0.17) and item 41 (0.15)). Because of these results, the related items were taken out of the model and analysed again.

The second CFA results were $\chi 2$ (df=260, p=.00)=572, $\chi 2$ 572/ df =2.2, RMSEA (Root Mean Square Error of Approximation)=.061, CFI (Comparative Fit Index)=0.94, NNFI (Non-Normed Fit Index)=0.93 indicated that the model is coherent at a satisfactory level.

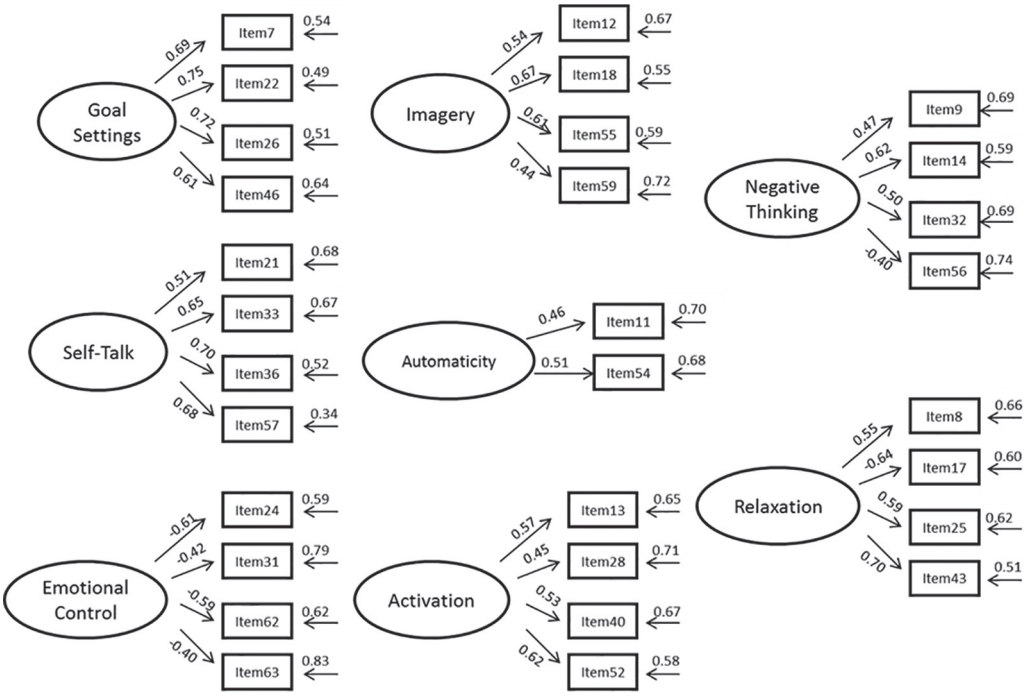


FIGURE 1 CFA Results for TOPS Competition Strategies

To estimate the reliability level of the competition sub-dimension, the Cronbach's alpha was used. Separately, the Cronbach's alpha level of each subscale and the overall of competition sub-dimension values were obtained. Per the results reported in the table below, the Cronbach's alpha coefficient for each variable is equal or greater than .58, and the Cronbach's alpha coefficient of competition sub-dimension was .81. Moreover, Analysis of "if item deleted" results did not yield any improvements.

TABLE 3 Cronbach's Alpha coefficients values of the competition sub-dimension

Values	No of Items	Items	Subscales
.64	4	21,33,36,57	Self-talk
.66	4	24,31,62,63	Negative Thinking
.58	2	11,54	Automaticity
.74	4	7,22,26,46	Goal Setting
.81	4	12,18,55,59	Imagery
.73	4	13,28,40,52	Activation
.78	4	9,14,32,56	Negative Thinking
.60	4	8,17,25,43	Relaxation
.88	30	8 subscales	Total alpha of competition

UDC 796.2:159.98(560)

The mean points taken from the competition strategies sub-dimension were 107.10 (S=23.29) for total, 15.34 (S=4.37) for the Self-Talk subscale, 13.67 (S=4.71) for the Emotional Control Subscale, 15.10 (S=4.05) for the Goal Setting subscale, 14.50 (S=4.64) for the Imagery subscale, 15.91 (S=3.99) for the Activation subscale, 15.07 (S=4.23) for the Relaxation subscale, 14.39 (S=4.64) for the Negative Thinking subscale, and 7.19 (S=2.42) for the Automaticity subscale.

CFA Analysis of Practice Strategies Sub-dimension

CFA was used to test the factor structure that shows the Practice strategies sub-dimension of the Test of Performance Strategies over the data gathered from athletes. Firstly, for a model with eight factors (activation, automaticity, emotional control, goal-setting, imagery, relaxation, self-talk and attention control) set in the original sub-dimension, goodness of fit (GOF) statistics were figured out. As a result of the analysis, $\chi 2$ (df=330, p=.00)=1392.6, $\chi 2$ 1392/ df =4.22, RMSEA (Root Mean Square Error of Approximation)=.195, CFI (Comparative Fit Index)=0.84, NNFI (Non-Normed Fit Index)=0.83 indicated that the model did not fit with the expected level. Concerning these results, it was detected the two items' factor loading were low in their own factor, two items that from automaticity subscale for competition strategies (item 23 (0.19) and item 48 (0.20)). Because of these results, the related items were taken out of the model and analysed again.

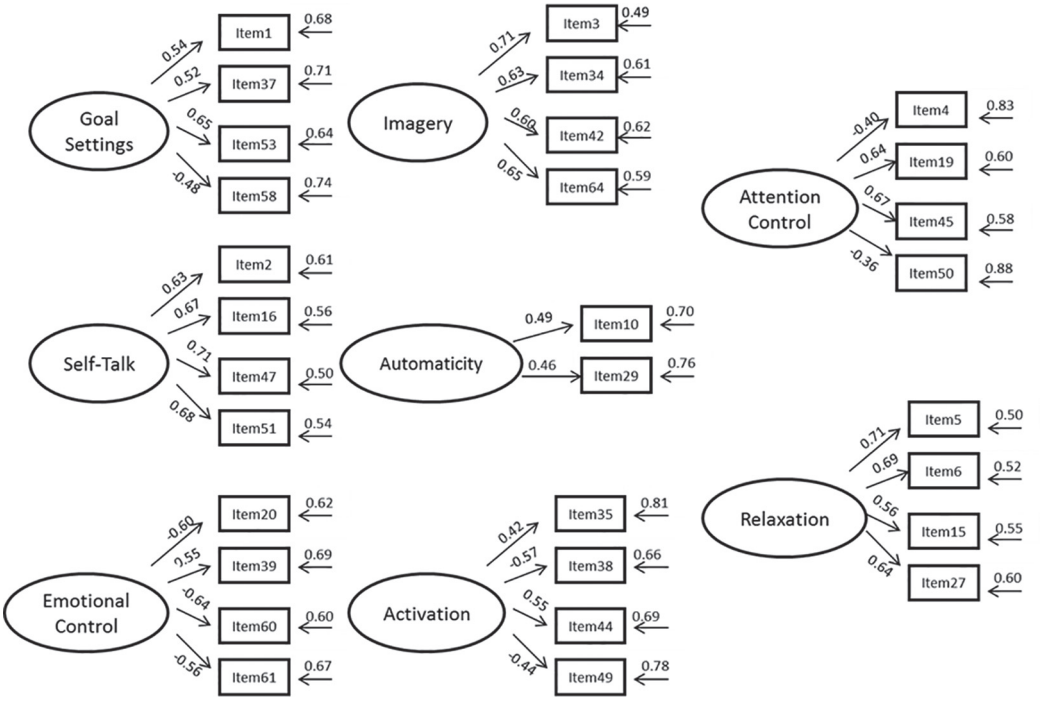


FIGURE 2 CFA Results for TOPS Practice Strategies

The second CFA results were $\chi 2$ (df=252, p=.00)=960.12, $\chi 2$ 960/ df =3.81, RMSEA (Root Mean Square Error of Approximation)=.138, CFI (Comparative Fit Index)=0.89 NNFI (Non-Normed Fit Index)=0.87 pointed out that the model did not fit with the expected level. Furthermore, modification indices were checked, and the pairs with high error covariances were connected (item 35, item 49 and item 4, item 50) and the model was revised again.

The third CFA results for practice strategies were $\chi 2$ (df=234, p=.00)=498.42, $\chi 2$ 498/ df =2.13, RMSEA (Root Mean Square Error of Approximation)=.054, CFI (Comparative Fit Index)=0.93, NNFI (Non-Normed Fit Index)=0.90 indicated that the model is coherent at a satisfactory level.

TABLE 4 Cronbach's Alpha coefficients values of the practice sub-dimension

Values	No of Items	Items	Subscales
.64	4	2,16,47,51	Self-talk
.74	4	20,39,60,61	Emotional Control
.55	2	10,29	Automaticity
.71	4	1,37,53,58	Goal Setting
.63	4	3,34,42,64	Imagery
.69	4	35,38,44,49	Activation
.76	4	4,19,45,50	Attentional Control
.76	4	5,6,15,27	Relaxation
.83	30	8 subscales	Total alpha of practice

To estimate the reliability level of the competition sub-dimension, Cronbach's alpha was used. Separately the Cronbach's alpha level of each subscale and the overall of practice sub-dimension values were obtained. According to the results reported in the table below, Cronbach's alpha coefficient for each variable is equal or greater than .55 and Cronbach's alpha coefficient of the practice sub-dimension was .83. Moreover, analysis of "if item deleted" results did not yield any improvements.

The mean points taken from the competition strategies sub-dimension were 112.36 (S=26.45) for the total, 15.81 (S=3.19) for the Self-Talk subscale, 13.64 (S=3.07) for the Emotional Control Subscale, 14.96 (S=3.04) for the Goal Setting subscale, 15.44 (S=3.03) for the Imagery subscale, 13.85 (S=3.17) for the Activation subscale, 14.18 (S=3.07) for the Relaxation subscale, 14.19 (S=3.00) for the Attentional Control subscale, and 7.36 (S=2.16) for the Automaticity subscale.

Discussion

In this study, the goal was to examine the psychometric properties of the Test of Performance Strategies (TOPS; Thomas et al., 1999) on a Turkish population. The confirmatory factor analysis was used and the data were collected from 620 athletes from 17 different sports. Confirmatory factor analysis results supported the initial structure of the inventory for the overall model. Cronbach's alpha values of competition sub-dimensions' subscales provided adequate scores for the internal consistency of the competition strategies. However, it should be noted that the subscale of automaticity demonstrated low factor loadings (item 11= .46 and item 54= .51) and the Cronbach's alpha values (.58). It can be attributed to the fact that this subscale has only two items and that amount is half the amount of others.

Moreover, there were seventeen sports with different features, and the environments (some of them with automatic execution; some of them with more focus to focus on technical aspects) of those sports can be the reason for that result. The items of automaticity for competition and practice strategies can confuse the participant's as they read them because of phrases like "automatic pilot", "flow naturally from one to another", "just seem to be in the flow" or "just let it happen". Those words are not commonly used in Turkish sport literature, so athletes could not understand clearly the exact meaning of the items.

The remaining items related with the automaticity subscale got acceptable but poor factor loading values (item 11= .46 and item 54= .51 for competition strategies and item1 0= .49 and item 29= .46); removing the subscale to protect the initial structure of the questionnaire was not considered. The general results of the reliability of competition and practice strategies separately confirmed the idea of not removing those subscales by having the Cronbach's alpha .88 for the competition and .83 for practice strategies sub-dimensions. In the study of Donti & Katsikas (2014), the automaticity subscale was in low factor loading; consequently, they decided to remove that subscale from the questionnaire. As a result, they reached acceptable model fit.

Furthermore, in their study Katsikas et al., (2011) despite having reached acceptable factor loadings for automaticity subscale, encountered difficulties regarding athletes clearly understanding the problem of automaticity items. In another study, Hardy et al. (2010) suggested giving more attention to the automaticity subscale items, and that they required re-examination and re-phrasing.

With the possible exception of four items, the present results show that the Turkish version of the Test of performance Strategies has quite strong psychometric properties: it is a valid and reliable test instrument to evaluate critical practice and competition strategies and to profile athletes' strengths and weaknesses in applied settings.

REFERENCES

Chartrand, J.M., Jowdy, D.P., & Danish, S.J. (1992). The Psychological Skills Inventory for Sports: Psychometric characteristics and applied implications. *Journal of Sport & Exercise Psychology*, 14, 405–413.

Donti, O., Katsikas, C., (2014). Factorial Validity of the test of performance strategies 2 – Competition scale in Greek Athletic Population, *Biology of Exercise*, 10.1, 13-22.

Hardy, L., Roberts, R., Thomas, P.R., Murphy, S.M. (2010) Test of Performance Strategies (TOPS): Instrument refinement using confirmatory factor analysis. *Psychology Sport & Exercise*, 1, 27-35.

Jaccard, J. & Wann, C. K. (1996). *LISREL approaches to interaction effects in multiple regression*. Thousand Oaks, CA: Sage Publications.

Katsikas, C., Donti, O., Psychountaki, M., (2011). Psychometric Properties of The Greek Version of the Test of Performance Strategies-Competition Scale (TOPS-CS). *Journal of Human Kinetics*, 29,133-139.

Lane A. M., Harwood C., Terry P.C., Karageorghis, C.I., (2004). Confirmatory factor analysis of the Test of Performance Strategies (TOPS) among adolescent athletes. *Journal of Sport Science*; 22,803–812.

Mahoney, M.J., Gabriel, T.J., & Perkins, T.S. (1987). Psychological skills and exceptional athletic performance. *Sport Psychologist*, 1, 181–199.

Malouff, J. M., J. A. McGee, H. T. Halford, and S. E. Rooke. (2008). Effects of pre-competition positive imagery and self-instructions on accuracy of serving in tennis. *Journal of Sport Behavior* 31(3):264-275.

Maruyama, G. M., (1998). *Basics of structural equation modeling*. Thousand Oaks, Ca: Sage.

McCann, S. (1995). Overtraining and burnout. *In Sport Psychology Interventions* (edited by S.M. Murphy), pp.

UDC 796.2:159.98(560)

347- 368. Champaign, IL: Human Kinetics.

Öcal, K., (2011). *Predicting Employee Performance in Non-Profit Sport Organizations: The Role of Managerial and Financial Performance and the Mediating Role of Support for Innovation and Individual Creativity*. Unpublished doctoral dissertation, Middle East Technical University, Turkey.

Ritz, N., (2012). The effects of mental preparation for distance runners, *Marathon & Beyond*, 2,120-130.

Sindik, J., Botica, A., Fiškuš, M. (2015). Preliminary psychometric validation of the Multidimensional Inventory of Sport Excellence: attention scales and mental energy. *Montenegrin Journal of Sports Science and Medicine, 4* (2), 17-28.

Smith, R.E. and Christensen, D.S. (1995). Psychological skills as predictors of performance and survival in professional baseball. *Journal of Sport and Exercise Psychology*, 17, 399-415.

Tenenbaum, G., & Eklund, R. C. (Eds.). (2007). *Handbook of sport psychology* (3rd ed.). New York: John Wiley.

Thomas, P.R., Murphy, S.M., & Hardy, L. (1999). Test of Performance Strategies: Development and preliminary validation of a comprehensive measure of athletes' psychological skills. *Journal of Sports Sciences*, 17(9), 697–711.

Weinberg R.S. & Gould, D. (2007). *Foundations of sport and exercise psychology*. Champaign, IL: Human Kinetics.

Wheaton, B., Muthen, B., Alwin, D., F., & Summers, G. (1977) Assessing Reliability and Stability in Panel Models. *Sociological Methodology*, 8 (1), 84-136.

White, S.A. (1993). The relationships between psychological skills, experience, and practice commitment among collegiate male and female skiers. *Sport Psychologist,* 7, 49–57.

ORIGINAL SCIENTIFIC PAPER

Local Geographical Differences in Adult Body Height in Montenegro

Stevo Popovic[1]

Affiliations: [1]University of Montenegro, Faculty for Sport and Physical Education, Niksic, Montenegro

Correspondence: Stevo Popovic, University of Montenegro, Faculty for Sport and Physical Education, Narodne omladine bb, 81400 Niksic, Montenegro. E-mail: stevop@ac.me

ABSTRACT The purpose of this research study is to examine body height in both Montenegrin sexes and map local geographical differences within both groups. A total of 2088 individuals (981 boys and 1107 girls) participated in this research study, and anthropometrical data were collected from 23 municipalities throughout the country. The anthropometric measurements were taken according to the ISAK protocol. Means and standard deviations were calculated for ages and anthropometric variable (body heights) as well as frequencies for the calculation of density of very short and very tall subjects. The results revealed that Montenegrin boys are 183.36±6.89 cm tall, while Montenegrin girls are 169.38±6.37 cm tall. The results of this study confirmed our assumption that both men and women in Montenegro are among the tallest people on the planet. However, the regional variation is considerable: from 181.25 cm in the municipality of Cetinje to 185.51 cm in the municipalities of Kolasin and Savnik for males and from 162.53 cm in the municipalities of Plav and Andrijevica to 170.86 cm in the municipality of Niksic for females. The measured values of body heights in Montenegro are currently one of the highest in the world, while the secular trend might increase it in the upcoming decades.

KEY WORDS Standing Height, Stature, Montenegro.

@MJSSMontenegro
ADULT HUMAN HEIGHT IN MONTENEGRO
http://mjssm.me/?sekcija=article&artid=135

Introduction

Over the course of the 20th century, adult body heights dramatically increased in Montenegro, in parallel to most industrialized countries (Schonbeck et al., 2013); it was about 5 centimeters on average. This trend is apparently caused by much better lifestyles that improved from decade to the decade, and it is reflected in better living conditions and the increased nutritional, hygienic, economic, and health status of the people studied (Hauspie, Vercauteren & Susanne, 1996).

Trends in men's body height have been analyzed in Europe, the USA and Japan for up to 250 years (cited in NCD Risk Factor Collaboration, 2016). There are fewer historical data for women and for children, because the focus was historically directed towards men, while the adult data tend to be cross-sectional or cover short periods (cited in NCD Risk Factor Collaboration, 2016). Nevertheless, the unusual height of Montenegrin highlanders was a fact recognized by European anthropologists more than a century ago (Bjelica et al., 2012). The widely recognized researcher Robert Ehrich conducted research at the beginning of the 20th century and measured 800 male Montenegrins (Coon, 1975) and proclaimed them to have the highest average height in all of Europe (177 cm), with some districts approaching 178 centimeters. In contrast, the same study stated that their counterparts in Herzegovina (geographically close) reached 175–176 centimeters. It is noteworthy that the majority of European countries barely reached 170 cm in this period (Coon, 1939). Generally, the entire population living in the Dinaric Alps has historically been renowned for the unusually large body size of its inhabitants (Coon, 1939; Coon, 1970). However, the problem is that unlike most Western countries, this region keeps poor records and any initiative that explores this area is of significance for anthropological research in general.

Accepted after revision: August 29 2016 | First published online: March 01 2017

Conflict of interest: None declared.

More recently, several research studies (Bjelica et al., 2012; Popovic, Bjelica, Georgiev, Krivokapic & Milasinovic, 2016; Bubanja, Vujovic, Tanase, Hadzic & Milazinovic, 2015; Vujovic, Bubanja, Tanase & Milasinovic, 2015; Milasinovic, Popovic, Matic, Gardasevic & Bjelica, 2016a; Milasinovic, Popovic, Jaksic, Vasilejvic & Bjelica, 2016b) that dealt with the adult body heights in Montenegro (more or less directly) have confirmed that Montenegrins are one of the tallest nations (both sexes) on the planet. However, none of these studies analyzed the local variation in adult body heights within the municipalities, which is also of interest, due to the various geographic characteristics. Therefore, the results of such studies would provide beneficial knowledge, due to the geographical diversity throughout Montenegro, and the scientific fact that tallest people live in the mountains (Pineau, Delamarche, & Bozinovic, 2005).

FIGURE 1 Municipalities in Montenegro

It is well-known in scientific literature that the measurement of adult body heights is important in many settings (cited in Popovic, Bjelica, Tanase & Milasinovic, 2015): it is a relevant measure of body size and gives an assessment of nutritional status, and a meaningful measure of determination of basic energy requirements, standardization of measures of physical capacity and adjusting drug dosage, evaluation of children's growth, prediction and standardization of physiological variables and talent identification, etc. (Golshan, Amra & Hoghoghi, 2003; Mohanty, Babu & Nair, 2001; Ter Goon, Toriola, Musa & Akusu, 2011; Popovic, Bjelica, Molnar, Jaksic & Akpinar, 2013; Popovic, Bjelica & Hadzic, 2014). Taller people might have enhanced longevity, have a lower risk of adverse pregnancy outcomes and cardiovascular and respiratory diseases, but have a higher risk of some cancers (cited in NCD Risk Factor Collaboration, 2016; Quanjer et al., 2014). There

UDC 572.512-053.8(497.16)

is also evidence that being taller is associated with higher level of education, higher monthly incomes, as well as higher level of position in its societies (cited in NCD Risk Factor Collaboration, 2016). Finally, adult body heights can also significantly influence success in sports.

With regard to the ongoing lack of representative anthropological research on the territory of Montenegro, the author of this study used the data from the conducted national survey, which was carried out in 2013, and analyzed local geographical differences. It covered a very large sample and enabled a detailed mapping of the local geographical differences within adult body heights among both genders. In this paper, the author has pooled Montenegrin population-based data to estimate body heights in adulthood for men and women living in available municipalities throughout Montenegro.

Methods

The nature and scope of this study qualifies 2088 final year students (981 males and 1107 females) from the secondary schools in Montenegro to be subjects. The sampling method is chosen parallel to the fact that the growth of both genders individual ceases by this age, while the age-related loss in body heights at this age is not recognized in the previous studies. The average male Montenegrins were between 17 and 20 years old (18.37±0.61), while the average female Montenegrins were between 17 and 20 years old (18.30±0.61). The exclusion criteria in this study were having physical deformities that could affect body heights and not having informed consent. The author also could not accept students who were non-Montenegrins.

The protocol of the International Society for the Advancement of Kinanthropometry (ISAK) was employed Marfell-Jones, Olds, Stew & Carter (2006), and the body height measurements were taken accordingly. The age of the study subjects was determined directly from their reported date of birth, while the trained measurers whose quality of performance had been evaluated against the prescribed "ISAK Manual" prior to the study performed these measurements. The frequencies of shorter (less than 170 and 160 centimeters) and taller individuals (above than 190 and 200 centimeters) are analyzed and presented separately (in percentages).

The analysis was carried out using SPSS version 20.0. Means and standard deviations were obtained for both genders from all available municipalities from all around of Montenegro.

Results

A summary of the body height measurements in the male population is shown in Table 1. The mean of the body heights for male subjects was 183.36±6.89 centimeters, while the tallest subjects live in central (183.58±6.95), the medium ones in northern (183.01±6.44) and the shortest in the southern regions (182.55±7.53) of Montenegro.

TABLE 1. Descriptive Statistics among Male Subjects

Municipality*	N	Age		Body Heights		
		Mean	SD	Mean	SD	Range
Bar & Ulcinj	50	18.28	0.64	182.13	7.47	163.6-199.0
Berane** & Rozaje	52	17.96	0.19	182.86	6.54	171.0-196.0
Plav*** & Andrijevica	25	17.60	0.50	181.26	6.98	170.2-195.2
Budva & Tivat	13	18.77	0.44	182.99	5.89	170.0-190.7
Kotor & Herceg Novi	24	18.04	0.55	183.17	8.62	170.2-198.2
Cetinje	74	18.26	0.76	181.25	6.06	165.1-202.0
Pljevlja	78	18.08	0.45	182.56	5.81	164.3-193.0
Danilovgrad	51	18.31	0.71	184.36	7.39	167.5-203.3
Podgorica	341	18.57	0.56	182.04	7.45	160.9-204.2
Niksic	168	18.63	0.49	184.57	6.57	166.1-200.9
Pluzine & Zabljak	28	17.71	0.60	184.88	5.78	172.0-196.5
Kolasin & Savnik	30	18.17	0.38	185.51	6.90	170.1-197.0
Mojkovac & Bijelo Polje	47	17.98	0.39	183.77	7.25	163.0-198.0
Northern Region	230	17.93	0.45	183.01	6.44	163.0-198.0
Central Region	664	18.53	0.58	183.58	6.95	160.9-204.2
Southern Region	87	18.29	0.63	182.55	7.53	163.6-199.0
Total	981	18.37	0.61	183.36	6.89	160.9-204.2

Legend: *- small municipalities are merged with the first neighboring municipality; **-Petnjica municipality is included; ***- Gusinje municipality is included.

A summary of the body height measurements in the female population is shown in Table 2. The mean of the body heights for female subjects was 169.38±6.37 centimeters, while the tallest subjects live in the central (169.70±6.27), the medium ones in the northern (168.84±6.36) and the shortest in the southern regions (168.76±6.79) of Montenegro.

TABLE 2 Descriptive Statistics among Female Subjects

Municipality*	N	Age		Body Heights		
		Mean	SD	Mean	SD	Range
Bar & Ulcinj	52	18.42	0.67	168.84	6.77	156.5-189.5
Berane** & Rozaje	37	18.08	0.28	169.24	5.15	160.0-179.0
Plav*** & Andrijevica	22	17.59	0.50	162.53	6.06	152.8-173.0
Budva & Tivat	40	18.90	0.38	168.95	7.42	153.8-187.7
Kotor & Herceg Novi	47	17.96	0.36	168.49	6.40	157.2-181.7
Cetinje	70	18.07	0.69	167.98	6.13	154.7-184.0
Pljevlja	108	18.09	0.38	169.54	6.24	155.5-183.3
Danilovgrad	49	18.33	0.66	168.37	6.60	151.5-182.2
Podgorica	362	18.50	0.57	168.54	6.33	150.2-193.4
Niksic	204	18.48	0.57	170.86	5.96	153.4-197.7
Pluzine & Zabljak	34	17.50	0.56	170.14	6.57	154.5-181.9
Kolasin & Savnik	26	18.15	0.37	169.82	7.09	151.0-183.0
Mojkovac & Bijelo Polje	56	17.91	0.29	168.90	6.11	156.0-185.6
Northern Region	257	17.93	0.45	168.84	6.36	152.8-185.6
Central Region	711	18.42	0.60	169.70	6.27	150.2-197.7
Southern Region	139	18.40	0.62	168.76	6.79	153.8-189.5
Total	1107	18.30	0.61	169.38	6.37	150.2-197.7

Legend: *- small municipalities are merged with the first neighboring municipality; **-Petnjica municipality is included; ***- Gusinje municipality is included.

Discussion

This research contributes to a beneficial update of adult human heights among both sexes in Montenegro, mostly because the reason the recent study conducted by NCD Risk Factor Collaboration (2016) did not adequately analyze the trends in adult human heights in Montenegro. The aforementioned study was a largest study ever in this area, analyzing 1472 populations in 200 countries and over 18.6 million participants to estimate adult human heights for people born between 1896 and 1996. However, this research excludes the current data from Montenegro, while the importance of its inclusion is established in the findings of Robert Ehrich, proving that Montenegrin males were the tallest population throughout Europe at the beginning of the 20th century (Coon, 1975), with an average height of 177 centimeters (the female population was not measured). Consequently, it is reasonable to assume the average adult human height in Montenegro is also currently among the highest (including females because they have the same genetic backgrounds as male population).

The results of this research study reveal that Montenegrin males are very tall, with an average of 183.4 centimeters and are one of the tallest nations in Europe and the entire world. Montenegrin males are shorter than Bosnian and Herzegovinian males measured in the Republic Srpska entity (183.9 centimeters) in 2013 (Popovic et al., 2015) and the Federation of BH Entity (183.8 centimeters) in 2015 (Gardasevic et al., 2017) as well as the Dutch male population (183.8 centimeters) measured in the last nationwide survey in 2010 (TNO, 2010). In contrast, Montenegrin males are taller than the 182 centimeters of the Serbian male population measured in 2012 (Popović et al., 2013), the 181.3 centimeters of Lithuanians (Tutkuviene, 2005), the 180.6 centimeters of Icelanders (Dagbjartsson, Thornórsson, Pálsson & Arnórsson, 2000), 180.5 centimeters of Croats (Juresa, Musil & Tiljak, 2012), 180.4 centimeters of the Swedes (Werner & Bodin, 2006), the 180.3 centimeters of Slovenes (Starc & Strel, 2011), Danes (Statistics Denmark, 2011), Czechs (Vignerová, Brabec & Bláha, 2006) et cetera.

The average height of Montenegrin females in this study is 169.4 centimeters, and this result proved that this population is also one of the tallest nations in the entire planet. Montenegrin females are shorter than females from Bosnia and Herzegovina with 171.8 centimeters (Popovic et al., 2015), the Netherlands with 170.7 centimeters (TNO, 2010), while this population is taller than females in Lithuania with 167.5 centimeters (Tutkuviene, 2005), Slovenia with 167.4 centimeters (Starc & Strel, 2011), Iceland and Czech Republic with 167.2 centimeters (Dagbjartsson et al., 2000; Vignerová at al. 2006), Latvia with 167.1 centimeters (Gerhards, 2005), Sweden with 167 centimeters (Werner & Bodin, 2006), etc.

However, there is an assumption that both genders of Montenegrins have not yet reached their full genetic potential yet regarding height, since they have been influenced by various environmental factors (wars, poor economic situation, etc.) in recent decades. Therefore, it is reasonable to assume these circumstances had a negative bearing on the secular trends in Montenegro. Consequently, the secular changes affecting adult human heights might rise in the following decades. It is interesting to add that this trend has already completed in the developed countries and it is confirmed that one of the world's tallest nations (the Dutch population)

UDC 572.512-053.8(497.16)

has stopped growing taller (Schonbeck et al., 2013) and this fact might push Western Balkan populations back among the tallest nations.

In contrast to the recent and the largest study in this area "A century of trends in adult human height", conducted by NCD Risk Factor Collaboration (2016), the results of this study confirmed our assumption that both male and female subjects from Montenegro are one of the tallest populations on the planet, the same as at the beginning of 20th century. However, the regional variation is considerable: from 181.25 cm in the municipality of Cetinje to 185.51 cm in the municipalities of Kolasin and Savnik for male and from 162.53 cm in the municipalities of Plav and Andrijevica to 170.86 cm in the municipality of Niksic for female subjects.

The density of very tall subjects appears to be characteristic of the Montenegrin males since 18.2% measured 190 centimeters or more in adult human heights. If the 18.2% in Montenegro compare to the 28% in Dinaric Alps (Pineau et al., 2005), the 20.2% in Bosnia and Herzegovina (Popovic et al., 2015), the 20% in the Netherlands (Pineau et al., 2005), the 14% in Serbia (Popović et al., 2012) and the mere 1.5% in France (Pineau et al., 2005), the of fact the density of very tall subjects in Montenegrin males is apparent. However, the density of very tall subjects in Montenegro did not reach the density of the Dinaric Alps population from Pineau et al.'s study (2005). Although all nations from Dinaric Alps were measured and did not individually reach the density of its summary, this fact leads to the assumption that individuals living in mountains might have a higher percentage of subjects with 190 centimeters or more in adult human heights (at the expense of those living in low-lying regions). However, the considerable regional variation in this study did not amplify this assumption, mostly due to the reason some mountain areas showed opposite results. It is also interesting to note that just 0.7% of subjects are taller than 200 centimeters, while no subjects were shorter than 160 centimeters and a low percentage of subjects was shorter than 170 centimeters (just 2.4%).

TABLE 3 Density of Very Short and Very Tall Male Subjects

Municipality*	Below 160 cm (%)	Below 170 cm (%)	Above 190 cm (%)	Above 200 cm (%)
Bar & Ulcinj	0	4.0	22	0
Berane** & Rozaje	0	0	21.5	0
Plav*** & Andrijevica	0	0	26	0
Budva & Tivat	0	0	25.4	0
Kotor & Herceg Novi	0	0	29.2	0
Cetinje	0	1.4	22.2	1.4
Pljevlja	0	2.6	9.0	0
Danilovgrad	0	2.0	25.5	2.0
Podgorica	0	4.8	23.1	1.2
Niksic	0	2.1	22.6	0.9
Pluzine & Zabljak	0	0	21.4	0
Kolasin & Savnik	0	0	33.3	0
Mojkovac & Bijelo Polje	0	6.4	21.3	0
Northern Region	0	2.2	14.3	0
Central Region	0	2.6	19.7	1.1
Southern Region	0	2.3	17.2	0
Total	0	2.4	18.2	0.7

Legend: *- small municipalities are merged with the first neighboring municipality; **-Petnjica municipality is included; ***- Gusinje municipality is included.

In contrast, the density of very tall subjects did not appear to be characteristic of the Montenegrin females, since just more than 5% measured 180 centimeters or more in adult human height. It is also noteworthy that just 0.2% of subjects taller than 190 centimeters, while there are no subjects shorter than 150 centimeters and a low percentage of subjects shorter than 160 centimeters (just 6.6%).

For better observation, the authors have prepared Table 3 and Table 4 to present an overview of the density of very short and very tall subjects among male and female populations in Montenegro. These results are significant for society, mostly because adult human height can significantly influence success in various sports disciplines, and this can help sport trainers to in talent identification when disciplines are linked to the specific heights (both shortness and height), as well as all other practitioners from other areas who need to enhance human longevity, to prevent the risk of adverse pregnancy outcomes and cardiovascular and respiratory diseases as well as some cancers, etc.

The overall perspective, based on the wide literature regarding adult human height, directs us to a more precise estimation of the average adult human heights in Europe and the entire world, since most previous studies did not include adequate study samples. Therefore, larger samples from various nations are required

TABLE 4 Density of Very Short and Very Tall Female Subjects

Municipality*	Below 150 cm (%)	Below 160 cm (%)	Above 180 cm (%)	Above 190 cm (%)
Bar & Ulcinj	0	5.8	7.7	0
Berane** & Rozaje	0	0	0	0
Plav*** & Andrijevica	0	31.8	0	0
Budva & Tivat	0	15.0	5.0	0
Kotor & Herceg Novi	0	8.5	6.4	0
Cetinje	0	14.3	2.9	0
Pljevlja	0	5.6	6.5	0
Danilovgrad	0	12.2	4.1	0
Podgorica	0	6.9	2.9	0.5
Niksic	0	3.3	5.5	0.3
Pluzine & Zabljak	0	5.9	5.9	0
Kolasin & Savnik	0	3.8	5.4	0
Mojkovac & Bijelo Polje	0	3.6	5.4	0
Northern Region	0	6.6	4.7	0
Central Region	0	6.0	4.8	0.3
Southern Region	0	9.4	6.5	0
Total	0	6.6	5.0	0.2

Legend: *- small municipalities are merged with the first neighboring municipality; **-Petnjica municipality is included; ***- Gusinje municipality is included.

and much more standardized procedures with sufficient geographical and social heterogeneity. Perhaps national surveys that measure whole populations shall be considered for this kind of comparison in the future.

REFERENCES

Bjelica, D., Popovic, S., Kezunovic, M., Petkovic, J., Jurak, G., & Grasgruber, P. (2012). Body Height and Its Estimation Utilizing Arm Span Measurements in Montenegrin Adults. *Anthropological Notebooks*, 18(2), 69–83.

Bubanja, M., Vujovic, D., Tanase, G.D., Hadzic, R. & Milazinovic, R. (2015). Body Height and Its Estimation Utilizing Arm Span Measurements in Female Adolescents from Central Region in Montenegro. *Sport Mont*, XII/43-45, 277-282.

Coon, C. (1939). *The races of Europe*. New York: Macmillan Publishers.

Coon, C. (1970). *The mountains of giants*. Papers of the Peabody Museum of American Anthropology. New York: Kraus Reprint Co.

Coon, C. (1975). *The races of Europe*. Westport, Conn: Greenwood Press.

Dagbjartsson, A., Thornórsson, A.V., Pálsson, G.I., & Arnórsson, V.H. (2000). Height and weight of Icelandic children 6-20 years of age (In Icelandic). *Laeknabladid*, 86(7/8), 509-514.

Gardasevic, J., Rasidagic, F., Krivokapic, D., Corluka, M., & Bjelica, D. (2017). Stature and Its Estimation Utilizing Arm Span Measurements in Male Adolescents from Federation of Bosnia and Herzegovina Entity in Bosnia and Herzegovina. *Montenegrin Journal of Sports Science and Medicine*, 6(1), 37-44.

Gerhards, G. (2005). Secular variations in the body stature of the inhabitants of Latvia (7th millennium BC – 20th c. AD). *Acta medica Lituanica*, 12(1), 33-39.

Golshan, M., Amra, B., & Hoghogi, M.A. (2003). Is arm span an accurate measure of height to predict pulmonary function parameters? *Monaldi Archives for Chest Disease*, 59(3), 189-192.

Hauspie, R.C., Vercauteren, M., Susanne, C. (1996). Secular changes in growth. *Hormone Research*, 45(Suppl.2), 8–17.

Juresa, V., Musil, V., & Tiljak, M.K. (2012). Growth charts for Croatian school children and secular trends in past twenty years. *Collegium Antropologicum*, 36(s1), 47-57.

Marfell-Jones, M., Olds, T., Stew, A.D., & Carter, J.E.L. (2006). *International standards for anthropometric assessment*. Potchesfstroom: International Society for the Advancement of Kinanthropometry.

Milasinovic, R., Popovic, S., Matic, R., Gardasevic, J. & Bjelica, D. (2016a). Body Height and its Estimation Utilizing Arm Span Measurements in Male Adolescents from Southern Region in Montenegro. *Sport Mont*, 14(2), 21–23.

Milasinovic, R., Popovic, S., Jaksic, D., Vasilejvic, I. & Bjelica, D. (2016b). Stature and its Estimation Utilizing Arm Span Measurements in Feale Adolescents from Southern Region in Montenegro. *Sport Mont*, 14(3), 15–18.

UDC 572.512-053.8(497.16)

Mohanty, S.P., Babu, S.S., & Nair, N.S. (2001). The use of arm span as a predictor of height. A study of South Indian women. *Journal of Orthopedics Surgery*, 9(1), 19-23.

NCD Risk Factor Collaboration (2016). A century of trends in adult human height. *eLife*, 5:e13410. Doi: 10.7554/eLife.13410.

Quanjer, P.H., Capderou, A., Mazocioglu, M.M., Aggarwal, A., Popovic, S., Datta Banik, S., Tayie, F.A.K., Golshan, M., Ip, M.S.M., Zelter, M. (2014). All-age relationship between arm span and height in different ethnic groups. *European Respiratory Journal*, 44(4), 905-912.

Pineau, J.C., Delamarche, P. & Bozinovic, S. (2005). Average height of adolescents in the Dinaric Alps (in French). *Comptes Rendus Biologies,* 328(9), 841–846.

Popovic, S., Bjelica, D., Molnar, S., Jaksic, D., & Akpinar, S. (2013). Body Height and Its Estimation Utilizing Arm Span Measurements in Serbian Adults. *International Journal of Morphology*, 31(1), 271-279.

Popovic, S., Bjelica, D., & Hadzic, R. (2014). Average body height of adolescents in Montenegro. In *Proceedings book of the 13th International Sport Sciences Congress* (462-463). Konya: Selcuk University.

Popovic, S., Bjelica, D., Tanase, G.D., & Milasinovic, R. (2015). Body Height and Its Estimation Utilizing Arm Span Measurements in Bosnian and Herzegovinian Adults. *Montenegrin Journal of Sports Science and Medicine*, 4(1), 29-36.

Popovic, S., Bjelica, D., Georgiev, G., Krivokapic, D. & Milasinovic, R. (2016). Body Height and its Estimation Utilizing Arm Span Measurements in Macedonian Adults. *Anthropologist*, 24(3), 737-745.

Schonbeck, Y., Talma, H., van Dommelen, P., Bakker, B., Buitendijk, S.E., HiraSing R.A. & van Buuren, S. (2013). The world's tallest nation has stopped growing taller: the height of Dutch children from 1955 to 2009. *Pediatric Research,* 73(3), 371-377.

Starc, G., & Strel, J. (2011). Is there a rationale for establishing Slovenian body mass index references of school-aged children and adolescents? *Anthropological Notebooks,* 17(3), 89-100.

Statistics Denmark. *Denmark's Statistical Yearbook 2011*, 2011. Retrieved on March 5, 2012, from http://www.www.dst.dk/.

Ter Goon, D., Toriola, A.T., Musa, D.I., & Akusu, S. (2011). The relationship between arm span and stature in Nigerian adults. *Kinesiology*, 43(1), 38-43.

TNO. *Lifelong Healthy and Active - PDF growth charts*, 2010. Retrieved on June 2, 2010, from http:// www.tno.nl/.

Tutkuviene, J. (2005). Sex and gender differences in secular trend of body size and frame indices of Lithuanians. *Anthropologischer anzeiger*, 63(1), 29-44.

Vignerová, J., Brabec, M., & Bláha, P. (2006). Two centuries of growth among Czech children and youth. *Economics and Human Biology*, 4(2), 237-252.

Vujovic, D., Bubanja, M., Tanase, G.D. & Milasinovic, R. (2015). Body Height and Its Estimation Utilizing Arm Span Measurements in Male Adolescents from Central Region in Montenegro. *Sport Mont*, XII/43-45, 283-288.

Werner, B., & Bodin, L. (2006). Growth from birth to age 19 for children in Sweden born in 1981: descriptive values. *Acta Paediatrica*, 95(5), 600-613.

Guidelines for Authors

Revised September 2014

*** Please use the bookmark function to navigate within the guidelines. ***

When preparing the final version of the manuscripts, either NEW or REVISED authors should strictly follow the guidelines. Manuscripts departing substantially from the guidelines will be returned to the authors for revision or, rejected.

1. UNIFORM REQUIREMENTS

1.1. Overview

The *Montenegrin Journal of Sports Science and Medicine* (MJSSM) reserves copyright of the materials published.

There is no charge for submissions and no page charge for accepted manuscripts. However, if the manuscript contains graphics in color, note that printing in color is charged.

MJSSM adopts a double-blind approach for peer reviewing in which the reviewer's name is always concealed from the submitting authors as well as the author(s)'s name from the selected reviewers.

MJSSM honors a six-weeks for an initial decision of manuscript submission.

Authors should submit the manuscripts as one Microsoft Word (.doc) file.

Manuscripts must be provided either in standard UK or US English. English standard should be consistent throughout the manuscripts.

Format the manuscript in A4 paper size; margins are 1 inch or 2.5 cm all around.

Type the whole manuscript double-spaced, justified alignment.

Use Times New Roman font, size eleven (11) point.

Number (Arabic numerals) the pages consecutively (centering at the bottom of each page), beginning with the title page as page 1 and ending with the Figure legend page.

Include line numbers (continuous) for the convenience of the reviewers.

Apart from chapter headings and sub-headings avoid any kind of formatting in the main text of the manuscripts.

1.2. Type & Length

MJSSM publishes following types of papers:

Original scientific papers are the results of empirically- or theoretically-based scientific research, which employ scientific methods, and which report experimental or observational aspects of sports science and medicine, such as all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side. Descriptive analyses or data inferences should include rigorous methodological structure as well as sound theory. Your manuscript should include the following sections: Introduction, Methods, Results, and Discussion.

☑Open Submissions ☑Indexed ☑Peer Reviewed

Original scientific papers should be:

- Up to 3000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 30;
- Maximum combined total of 6 Tables/Figures.

Review papers should provide concise in-depth reviews of both established and new areas, based on a critical examination of the literature, analyzing the various approaches to a specific topic in all aspects of sports science and medicine, such as all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side.

☑Open Submissions ☑Indexed ☑Peer Reviewed

Review papers should be:

- Up to 6000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 100.

Editorials are written or commissioned by the editors, but suggestions for possible topics and authors are welcome. It could be peer reviewed by two reviewers who may be external or by the Editorial Board.

☐Open Submissions ☑Indexed ☑Peer Reviewed

Editorials should be:

- Up to 1000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 10.

Short reports of experimental work, new methods, or a preliminary report can be accepted as two page papers. Your manuscript should include the following sections: Introduction, Methods, Results, and Discussion.

☑Open Submissions ☑Indexed ☑Peer Reviewed

Short reports should be:

- Up to 1500 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 15.

Peer review - fair review provides authors who feel their paper has been unfairly rejected (at any journal) the opportunity to share reviewer comments, explain their concerns, and have their paper reviewed for possible publication in MJSSM.

☑Open Submissions ☑Indexed ☐Peer Reviewed

Peer review - fair review should be:

- Up to 1500 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 15.

Invited papers and award papers include invited papers from authors with outstanding scientific credentials. Nomination of invited authors is at the discretion of the MJSSM editorial board. MJSSM also publishes award papers selected by the scientific committee of the International Scientific Conference on Transformation Processes in Sport.

☐Open Submissions ☑Indexed ☐Peer Reviewed

Invited papers and award papers should be:

- Up to 3000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 30;
- Maximum combined total of 6 Tables/Figures.

1.3. Submission

MJSSM only accepts electronic submission to the e-mail of the Journal Office: **office@mjssm.me**.

Submitted material includes:

- A manuscript prepared according to the Guidelines for the Authors;
- A signed form that states the study was not previously published, nor has been submitted simultaneously for consideration of publication elsewhere, that states that all of the authors are in agreement with submission of the manuscript to MJSSM, and that, for studies that use animal or human individuals, authors must include information regarding their institution's ethics committee, and which identifies the official approval number;
- A signed form that there is no conflict of interest.

Name the files according to the family name of the first author. Authors submitting revised versions of the manuscript can use the identification number of their manuscript as provided by the Journal Office. *See* example:

- ✓ FAMILY NAME-manuscript.doc – (main manuscript file)
- ✓ FAMILY NAME-statement.PDF – (authorship statement)
- ✓ FAMILY NAME-declaration.PDF – (declaration of potential conflict of interest)
- ✓ FAMILY NAME-fig1.tiff – (Figure 1)

1.4. Peer Review Process

An original manuscript submitted for publication will be submitted to the review process as long as it fits the following criteria:

- The study was not previously published, nor has been submitted simultaneously for consideration of publication elsewhere;
- All persons listed as authors approved its submission to MJSSM;
- Any person cited as a source of personal communication has approved the quote;
- The opinions expressed by the authors are their exclusive responsibility;
- The author signs a formal statement that the submitted manuscript complies with the directions and guidelines of MJSSM.

The editors-in-chief and associate editors will make a preliminary analysis regarding the appropriateness, quality, originality and written style/grammar of the submitted manuscript. The editors reserve the right to request additional information, corrections, and guideline compliance before they submit the manuscript to the ad-hoc review process.

MJSSM uses ad-hoc reviewers, who volunteer to analyze the merit of the study. Typically, one or two expert reviewers are consulted in a double-blind process. Authors are notified by e-mail when their submission has been accepted (or rejected). Minor changes in the text may be made at the discretion of the editors-in-chief and/or associate editors. Changes can include spelling and grammar in the chosen language, written style, journal citations, and reference guidelines. The author is notified of changes via email. The final version is available to the author for his or her approval before it is published.

1.5. Publisher Copyright Policies

Copyright of published articles are the property of MJSSM, and under no circumstance will the Journal transfer rights of published work. Reproduction of portions of published articles in other publications, or for any other use, is subject to written permission by the editors-in-chief. Reproductions of published work by MJSSM, under a maximum of 500 words, are allowed with proper citation references and quotations.

Authors partially reproducing others' published work-whether by a different author or his or her own-exceeding 500 words, or that includes tables, figures, and other illustrations, must have written permission from the author and/or journal holding copyrights of such work. We strongly discourage authors who include multiple reproductions of published work in order to avoid perceptions of plagiarism or self-plagiarism by reviewers and the editorial board.

Upon acceptance of an article, authors will be asked to complete a "Journal Publishing Agreement". Acceptance of the agreement will ensure the widest possible dissemination of information. An email will be sent to the corresponding author confirming receipt of the manuscript together with a "Journal Publishing Agreement" form or a link to the online version of this agreement.

The editors of MJSSM consider plagiarism and self-plagiarism to be a serious breach of academic ethics. Any author who practices plagiarism and/or self-plagiarism (in part or totality) will be suspended for six years from submitting new submissions to MJSSM. If such a manuscript is approved and published, public exposure of the article with a printed mark ("plagiarized" or "retracted") on each page of the published file, as well as suspension for future publication for at least six years, or a period determined by the editorial board. Third party plagiarized authors or institutions will be notified, informing them about the faulty authors. Plagiarism and self-plagiarism will result in immediate rejection of the manuscript.

MJSSM only publishes studies that have been approved by an institutional ethics committee (when a study involves humans or animals). Fail to provide such information prevent its publication. To ensure these requirements, it is essential that submission documentation is complete. If you have not completed this step yet, go to MJSSM website and fill out the two required documents: Declaration of Potential Conflict of Interest and Authorship Statement. Whether or not your study uses humans or animals, these documents must be completed and signed by all authors and attached as supplementary files in the originally submitted manuscript.

☑ Authors can archive pre-print (i.e., pre-refereeing)
☑ Authors can archive post-print (i.e., final draft post-refereeing)
☑ Authors can archive publisher's version/PDF

1.6. After Acceptance

After the manuscript has been accepted, authors will receive a PDF version of the manuscripts for authorization, as it should look in printed version of MJSSM. Authors should carefully check for omissions. Reporting errors after this point will not be possible and the Editorial Board will not be eligible for them.

Should there be any errors, authors should report them to the Office e-mail address **office@mjssm.me**. If there are not any errors authors should also write a short e-mail stating that they agree with the received version.

1.7. Code of Conduct Ethics Committee of Publications

MJSSM is hosting the Code of Conduct Ethics Committee of Publications of the **COPE** (the Committee on Publication Ethics), which provides a forum for publishers and Editors of scientific journals to discuss issues relating to the integrity of the work submitted to or published in their journals.

2. MANUSCRIPT STRUCTURE

2.1. Title Page

The first page of the manuscripts should be the title page, containing: title, type of publication, running head, authors, affiliations, corresponding author, and manuscript information. *See* example:

Transfer of Learning on a Spatial Memory Task between the Blind and Sighted People Spatial Memory among Blind and Sighted

Original Scientific Paper

Transfer of learning on a spatial memory task

Selcuk Akpinar[1], Stevo Popović[1,2], Sadettin Kirazci[1]

[1]Middle East Technical University, Physical Education and Sports Department, Ankara, Turkey
[2]University of Montenegro, Faculty for Sport and Physical Education, Niksic, Montenegro

Corresponding author:
S. Popovic
University of Montenegro
Faculty for Sport and Physical Education
Narodne omladine bb, 84000 Niksic, Montenegro
E-mail:

Word count: 2,980

Abstract word count: 236

Number of Tables: 3

Number of Figures: 3

2.1.1. Title

Title should be short and informative and the recommended length is no more than 20 words. The title should be in Title Case, written in uppercase and lowercase letters (initial uppercase for all words except articles, conjunctions, short prepositions no longer than four letters etc.) so that first letters of the words in the title are capitalized. Exceptions are words like: "and", "or", "between" etc. The word following a colon (:) or a hyphen (-) in the title is always capitalized.

2.1.2. Type of publication

Authors should suggest the type of their submission.

2.1.3. Running head

Short running title should not exceed 50 characters including spaces.

2.1.4. Authors

The form of an author's name is first name, middle initial(s), and last name. In one line list all authors with full names separated by a comma (and space). Avoid any abbreviations of academic or professional titles. If authors belong to different institutions, following a family name of the author there should be a number in superscript designating affiliation.

2.1.5. Affiliations

Affiliation consists of the name of an institution, department, city, country/territory(in this order) to which the author(s) belong and to which the presented / submitted work should be attributed. List all affiliations (each in a separate line) in the order corresponding

to the list of authors. Affiliations must be written in English, so carefully check the official English translation of the names of institutions and departments.

Only if there is more than one affiliation, should a number be given to each affiliation in order of appearance. This number should be written in superscript at the beginning of the line, separated from corresponding affiliation with a space. This number should also be put after corresponding name of the author, in superscript with no space in between.

If an author belongs to more than one institution, all corresponding superscript digits, separated with a comma with no space in between, should be present behind the family name of this author.

In case all authors belong to the same institution affiliation numbering is not needed.

Whenever possible expand your authors' affiliations with departments, or some other, specific and lower levels of organization.

2.1.6. Corresponding author

Corresponding author's name with full postal address in English and e-mail address should appear, after the affiliations. It is preferred that submitted address is institutional and not private. Corresponding author's name should include only initials of the first and middle names separated by a full stop (and a space) and the last name. Postal address should be written in the following line in sentence case. Parts of the address should be separated by a comma instead of a line break. E-mail (if possible) should be placed in the line following the postal address. Author should clearly state whether or not the e-mail should be published.

2.1.7. Manuscript information

All authors are required to provide word count (excluding title page, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References), the Abstract word count, the number of Tables, and the number of Figures.

2.2. Abstract

The second page of the manuscripts should be the abstract and key words. It should be placed on second page of the manuscripts after the standard title written in upper and lower case letters, bold.

Since abstract is independent part of your paper, all abbreviations used in the abstract should also be explained in it. If an abbreviation is used, the term should always be first written in full with the abbreviation in parentheses immediately after it. Abstract should not have any special headings (e.g., Aim, Results…).

Authors should provide up to six key words that capture the main topics of the article. Terms from the Medical Subject Headings (MeSH) list of Index Medicus are recommended to be used.

Key words should be placed on the second page of the manuscript right below the abstract, written in italic. Separate each key word by a comma (and a space). Do not put a full stop after the last key word. *See* example:

Abstract

Results of the analysis of…

Key words: spatial memory, blind, transfer of learning, feedback

2.3. Main Chapters

Starting from the third page of the manuscripts, it should be the main chapters. Depending on the type of publication main manuscript chapters may vary. The general outline is: Introduction, Methods, Results, Discussion, Acknowledgements (optional), Conflict of Interest (optional), and Title and Abstract in Montenegrin (only for the authors from former Yugoslavia, excluding Macedonians and Slovenes). However, this scheme may not be suitable for reviews or publications from some areas and authors should then adjust their chapters accordingly but use the general outline as much as possible.

2.3.1. Headings

Main chapter headings: written in bold and in Title Case. *See* example:

- ✓ **Methods**

Sub-headings: written in italic and in normal sentence case. Do not put a full stop or any other sign at the end of the title. Do not create more than one level of sub-heading. *See* example:

- ✓ *Table position of the research football team*

2.3.2 Ethics

When reporting experiments on human subjects, there must be a declaration of Ethics compliance. Inclusion of a statement such as follow in Methods section will be understood by the Editor as authors' affirmation of compliance: "This study was approved in advance by [name of committee and/or its institutional sponsor]. Each participant voluntarily provided written informed consent before participating." Authors that fail to submit an Ethics statement will be asked to resubmit the manuscripts, which may delay publication.

2.3.3 Statistics reporting

MJSSM encourages authors to report precise p-values. When possible, quantify findings and present them with appropriate indicators of measurement error or uncertainty (such as confidence intervals). Use normal text (i.e., non-capitalized, non-italic) for statistical term "p".

2.3.4. 'Acknowledgements' and 'Conflict of Interest' (optional)

All contributors who do not meet the criteria for authorship should be listed in the 'Acknowledgements' section. If applicable, in 'Conflict of Interest' section, authors must clearly disclose any grants, financial or material supports, or any sort of technical assistances from an institution, organization, group or an individual that might be perceived as leading to a conflict of interest.

2.4. References

References should be placed on a new page after the standard title written in upper and lower case letters, bold.

All information needed for each type of must be present as specified in guidelines. Authors are solely responsible for accuracy of each reference. Use authoritative source for information such as Web of Science, Medline, or PubMed to check the validity of citations.

2.4.1. References style

MJSSM adheres to the American Psychological Association 6th Edition reference style. Check "American Psychological Association. (2009). Concise rules of APA style. American Psychological Association." to ensure the manuscripts conform to this reference style. Authors using EndNote® to organize the references must convert the citations and bibliography to plain text before submission.

2.4.2. Examples for Reference citations

One work by one author

- ✓ In one study (Reilly, 1997), soccer players…
- ✓ In the study by Reilly (1997), soccer players…
- ✓ In 1997, Reilly's study of soccer players…

Works by two authors

- ✓ Duffield and Marino (2007) studied…
- ✓ In one study (Duffield & Marino, 2007), soccer players…
- ✓ In 2007, Duffield and Marino's study of soccer players…

Works by three to five authors: cite all the author names the first time the reference occurs and then subsequently include only the first author followed by et al.

- ✓ First citation: Bangsbo, Iaia, and Krustrup (2008) stated that…
- ✓ Subséquent citation: Bangsbo et al. (2008) stated that…

Works by six or more authors: cite only the name of the first author followed by et al. and the year

- ✓ Krustrup et al. (2003) studied…
- ✓ In one study (Krustrup et al., 2003), soccer players…

Two or more works in the same parenthetical citation: Citation of two or more works in the same parentheses should be listed in the order they appear in the reference list (i.e., alphabetically, then chronologically)

- ✓ Several studies (Bangsbo et al., 2008; Duffield & Marino, 2007; Reilly, 1997) suggest that…

2.4.3. Examples for Reference list

Journal article (print):

Bangsbo, J., Iaia, F. M., & Krustrup, P. (2008). The Yo-Yo intermittent recovery test: a useful tool for evaluation of physical performance in intermittent sports. *Sports Medicine, 38*(1), 37-51.

Duffield, R., & Marino, F. E. (2007). Effects of pre-cooling procedures on intermittent-sprint exercise performance in warm conditions. *European Journal of Applied Physiology, 100*(6), 727-735.

Krustrup, P., Mohr, M., Amstrup, T., Rysgaard, T., Johansen, J., Steensberg, A., . . . Bangsbo, J. (2003). The yo-yo intermittent recovery test: physiological response, reliability, and validity. *Medicine and Science in Sports and Exercise, 35*(4), 697-705.

Journal article (online; electronic version of print source):

Shaw, A. (1999). The planning and development of New Bombay [Electronic version]. *Modern Asian Studies, 33*(4), 951-988.

Journal article (online; electronic only):

Chantavanich, S. (2003, October). Recent research on human trafficking. *Kyoto Review of Southeast Asia, 4*. Retrieved November 15, 2005, from http://kyotoreview.cseas.kyoto-u.ac.jp/issue/issue3/index.html

Conference paper:

Pasadilla, G. O., & Milo, M. (2005, June 27). *Effect of liberalization on banking competition*. Paper presented at the conference on Policies to Strengthen Productivity in the Philippines, Manila, Philippines. Retrieved August 23, 2006, from http://siteresources.worldbank.org/INTPHILIPPINES/Resources/Pasadilla.pdf

Encyclopedia entry (print, with author):

Pittau, J. (1983). Meiji constitution. In *Kodansha encyclopedia of Japan* (Vol. 2, pp. 1-3). Tokyo: Kodansha.

Encyclopedia entry (online, no author):

Ethnology. (2005, July). In *The Columbia encyclopedia* (6th ed.). New York: Columbia University Press. Retrieved November 21, 2005, from http://www.bartleby.com/65/et/ethnolog.html

Thesis and dissertation:

Pyun, D. Y. (2006). *The proposed model of attitude toward advertising through sport.* Unpublished Doctoral Dissertation. Tallahassee, FL: The Florida State University.

Book:

Borg, G. (1998). *Borg's perceived exertion and pain scales*: Human kinetics.

Chapter of a book:

Kellmann, M. (2012). Chapter 31-Overtraining and recovery: Chapter taken from Routledge Handbook of Applied Sport Psychology ISBN: 978-0-203-85104-3 *Routledge Online Studies on the Olympic and Paralympic Games* (Vol. 1, pp. 292-302).

Reference to an internet source:

Agency. (2007). Water for Health: Hydration Best Practice Toolkit for Hospitals and Healthcare. Retrieved 10/29, 2013, from www.rcn.org.uk/newsevents/hydration

2.5. Tables

All tables should be included in the main manuscript file, each on a separate page right after the Reference section.

Tables should be presented as standard MS Word tables.

Number (Arabic) tables consecutively in the order of their first citation in the text.

Tables and table headings should be completely intelligible without reference to the text. Give each column a short or abbreviated heading. Authors should place explanatory matter in footnotes, not in the heading. All abbreviations appearing in a table and not considered standard must be explained in a footnote of that table. Avoid any shading or coloring in your tables and be sure that each table is cited in the text.

If you use data from another published or unpublished source, it is the authors' responsibility to obtain permission and acknowledge them fully.

2.5.1. Table heading

Table heading should be written above the table, in Title Case, and without a full stop at the end of the heading. Do not use suffix letters (e.g., Table 1a, 1b, 1c); instead, combine the related tables. *See* example:

- ✓ **Table 1.** Repeated Sprint Time Following Ingestion of Carbohydrate-Electrolyte Beverage

2.5.2. Table sub-heading

All text appearing in tables should be written beginning only with first letter of the first word in all capitals, i.e., all words for variable names, column headings etc. in tables should start with the first letter in all capitals. Avoid any formatting (e.g., bold, italic, underline) in tables.

2.5.3. Table footnotes

Table footnotes should be written below the table.

General notes explain, qualify or provide information about the table as a whole. Put explanations of abbreviations, symbols, etc. here. General notes are designated by the word *Note* (italicized) followed by a period.

- ✓ *Note.* CI: confidence interval; Con: control group; CE: carbohydrate-electrolyte group.

Specific notes explain, qualify or provide information about a particular column, row, or individual entry. To indicate specific notes, use superscript lowercase letters (e.g. $^{a, b, c}$), and order the superscripts from left to right, top to bottom. Each table's first footnote must be the superscript ^{a}.

- ✓ ^{a}One participant was diagnosed with heat illness and n = 19.^{b}n =20.

Probability notes provide the reader with the results of the texts for statistical significance. Probability notes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || etc.

- ✓ *P<0.05,†p<0.01.

2.5.4. Table citation

In the text, tables should be cited as full words. *See* example:

- ✓ Table 1 (first letter in all capitals and no full stop)
- ✓ ...as shown in Tables 1 and 3. (citing more tables at once)
- ✓ ...result has shown (Tables 1-3) that... (citing more tables at once)
- ✓ ....in our results (Tables 1, 2 and 5)... (citing more tables at once)

2.6. Figures

On the last separate page of the main manuscript file, authors should place the legends of all the figures submitted separately.

All graphic materials should be of sufficient quality for print with a minimum resolution of 600 dpi. MJSSM prefers TIFF, EPS and PNG formats.

If a figure has been published previously, acknowledge the original source and submit a written permission from the copyright holder to reproduce the material. Permission is required irrespective of authorship or publisher except for documents in the public domain. If photographs of people are used, either the subjects must not be identifiable or their pictures must be accompanied by written permission to use the photograph whenever possible permission for publication should be obtained.

Figures and figure legends should be completely intelligible without reference to the text.

The price of printing in color is 50 EUR per page as printed in an issue of MJSSM.

2.6.1. Figure legends

Figures should not contain footnotes. All information, including explanations of abbreviations must be present in figure legends. Figure legends should be written bellow the figure, in sentence case. *See* example:

- ✓ **Figure 1.** Changes in accuracy of instep football kick measured before and after fatigued. SR – resting state, SF – state of fatigue, *p>0.01, †p>0.05.

2.6.2. Figure citation

All graphic materials should be referred to as Figures in the text. Figures are cited in the text as full words. *See* example:

- ✓ Figure 1
- × figure 1
- × Figure 1.
- ✓ ….exhibit greater variance than the year before (Figure 2). Therefore…
- ✓ ….as shown in Figures 1 and 3. (citing more figures at once)
- ✓ ….result has shown (Figures 1-3) that... (citing more figures at once)
- ✓ ….in our results (Figures 1, 2 and 5)... (citing more figures at once)

2.6.3. Sub-figures

If there is a figure divided in several sub-figures, each sub-figure should be marked with a small letter, starting with a, b, c etc. The letter should be marked for each subfigure in a logical and consistent way. *See* example:

- ✓ Figure 1a
- ✓ …in Figures 1a and b we can…
- ✓ …data represent (Figures 1a-d)…

2.7. Scientific Terminology

All units of measures should conform to the International System of Units (SI).

Measurements of length, height, weight, and volume should be reported in metric units (meter, kilogram, or liter) or their decimal multiples.

Decimal places in English language are separated with a full stop and not with a comma. Thousands are separated with a comma.

Percentage	Degrees	All other units of measure	Ratios	Decimal numbers
✓ 10%	✓ 10°	✓ 10 kg	✓ 12:2	✓ 0.056
× 10 %	× 10 °	× 10kg	× 12 : 2	× .056

Signs should be placed immediately preceding the relevant number.		
✓ 45±3.4	✓ p<0.01	✓ males >30 years of age
× 45 ± 3.4	× p < 0.01	× males > 30 years of age

2.8. Latin Names

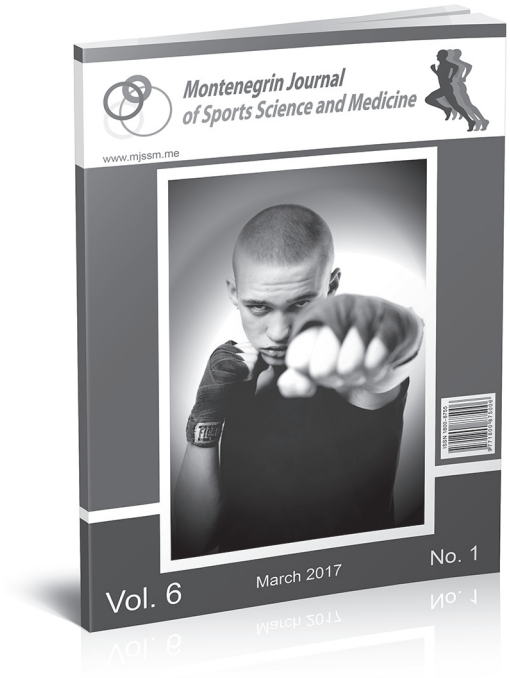
Latin names of species, families etc. should be written in italics (even in titles). If you mention Latin names in your abstract they should be written in non-italic since the rest of the text in abstract is in italic. The first time the name of a species appears in the text both genus and species must be present; later on in the text it is possible to use genus abbreviations. *See* example:

- ✓ First time appearing: *musculus biceps brachii*

Abbreviated: *m. biceps brachii*

Montenegrin Journal of Sports Science and Medicine

MONTENEGRIN JOURNAL OF SPORTS SCIENCE AND MEDICINE



ISSN 1800-8755

CALL FOR CONTRIBUTIONS

Montenegrin Journal of Sports Science and Medicine (MJSSM) is a print (ISSN 1800-8755) and electronic scientific journal (eISSN 1800-8763) aims to present easy access to the scientific knowledge for sport-conscious individuals using contemporary methods. The purpose is to minimize the problems like the delays in publishing process of the articles or to acquire previous issues by drawing advantage from electronic medium. Hence, it provides:

- Open-access and freely accessible online;
- Fast publication time;
- Peer review by expert, practicing researchers;
- Post-publication tools to indicate quality and impact;
- Community-based dialogue on articles;
- Worldwide media coverage.

MJSSM is published biannually, in September and March of each year. MJSSM publishes original scientific papers, review papers, editorials, short reports, peer review - fair review, as well as invited papers and award papers in the fields of Sports Science and Medicine, as well as it can function as an open discussion forum on significant issues of current interest.

MJSSM covers all aspects of sports science and medicine; all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side.

Prospective authors should submit manuscripts for consideration in Microsoft Word-compatible format. For more complete descriptions and submission instructions, please access the Guidelines for Authors pages at the MJSSM website: http://www.mjssm.me/?sekcija=page&p=51. Contributors are urged to read MJSSM's guidelines for the authors carefully before submitting manuscripts. Manuscripts submissions should be sent in electronic format to office@mjssm.me or contact following Editors:

Dusko BJELICA, Editor-in Chief – dbjelica@ac.me
Stevo POPOVIC, Editor-in Chief – stevop@ac.me
Selçuk AKPINAR, Executive Editor – sakpinar@nevsehir.edu.tr

Publication date: Spring issue – March 2017
Autumn issue – September 2017

USEFUL CONTACTS

Editorial enquiries and journal proposals:
Dusko Bjelica
Stevo Popovic
Editors-in-Chief
Email: **office@mjssm.me**

Selcuk Akpinar
Executive Editor
Email: **office@mjssm.me**

Marketing enquiries:
Rajko Milasinovic
Marketing Manager
Email: **administration@mjssm.me**

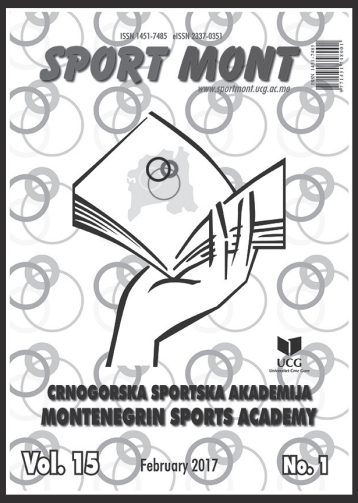
Sports Science and Medicine Journals

from Montenegrin Sports Academy

We have expanded the quality of our journals considerably over the past years and can now claim to be the market leader in terms of breadth of coverage.

As we continue to increase the quality of our publications across the field, we hope that you will continue to regard MSA journals as authoritative and stimulating sources for your research. We would be delighted to receive your comments and suggestions, mostly due to the reason your proposals are always welcome.

Look Inside!



Sport Mont Journal

Editor-in-Chief: **Dusko Bjelica**, Montenegro
Director: **Batric Markovic**, Montenegro
Managing Editor: **Jovan Gardasevic**, Montenegro

Volume 15, 2017, 3 issues per year; Print ISSN: 1451-7485, Online ISSN: 2337-0351

Sport Mont is a scientific journal that provides: Open-access and freely accessible online, authors retain copyright; Fast publication times; Peer review by expert, practicing researchers; Post-publication tools to indicate quality and impact; Community-based dialogue on articles; and Worldwide media coverage. Sport Mont is published once a year and publishes original scientific papers, notes, preliminary communications, reviews and conference papers in the fields of Sports Science and Medicine, as well as editorials, a "letter to the editor" section, abstracts from international and national congresses, panel meetings, conferences and symposia, and can function as an open discussion forum on significant issues of current interest.

www.sportmont.ucg.ac.me

Montenegrin Journal of Sports Science and Medicine

Editors-in-Chief: **Dusko Bjelica**, Montenegro; **Stevo Popovic**, Montenegro
Executive Editor: **Selçuk Akpınar**, Turkey
Associate Editors: **Mehmet Uygur**, USA; **Catalina Casaru**, USA; and **Predrag Bozic**, Serbia

Volume 6, 2017, 2 issues per year; Print ISSN: 1800-8755, Online ISSN: 1800-8763

Montenegrin Journal of Sports Science and Medicine (MJSSM) is published biannually, in September and March of each year. MJSSM publishes original scientific papers, review papers, editorials, short reports, peer review - fair review, as well as invited papers and award papers in the fields of Sports Science and Medicine, as well as it can function as an open discussion forum on significant issues of current interest. MJSSM covers all aspects of sports science and medicine; all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side.

www.mjssm.me

UNIVERZITET CRNE GORE
FAKULTET ZA POMORSTVO – KOTOR

UNIVERSITY OF MONTENEGRO
MARITIME FACULTY - KOTOR

In addition to maritime education in navigation and marine engineering, University of Montenegro - Maritime Faculty in Kotor also provides additional training for professional seafarers in:

- Different IMO model courses
- DP - Dynamic positioning courses
- Offshore courses

From 2015 runs the newly established joint training center with partners from NTNU - Aallesund in Norway, being one of the most experienced and most successful in providing offshore and DP training courses worldwide. The up-to-date bridge simulator, accompanied by AB simulations and instructor station, enables the organization of all the courses held as in the Norwegian training centers, with the same team of instructors and certificates. So far, a series of courses have been organized related to the operation of complex offshore equipment and team work in these demanding operations, both for students and international crews. In addition, the Kotor/Aalesund training center has recently been awarded with the Nautical Institute accreditation for holding DP (Induction and Simulator) trainings and so far has successfully launched several groups of DP operators.

OSC offshore simulator at Maritime Faculty Kotor, Montenegro

Dobrota 36, 85330 Kotor
Tel/Fax ++382(0)32 - 303 - 184
Centrala ++382(0)32 - 303 - 188
fzp@ac.me, www.fzp.ucg.ac.me

Ž.R. 510-227-38
PIB 02016702
PDV 30/31-03951-6

University of Montenegro

Cetinjska br.2
81 000 Podgorica
Montenegro

E-mail:
rektor@ac.me
rektorat@ac.me

Phone: + 382 20 414 255
Fax: + 382 20 414 230

Web:
www.ucg.ac.me

The University of Montenegro is the leading higher education and research institution in Montenegro. It is a public institution, established by the state, operating as a unique legal entity represented by the Rector. It is an integrated university organized on the model of the most European universities. Organizational units are competent for provision of study programmes, scientific-research and artistic work, use of allocated funds and membership in professional associations.

Since its foundation, the University of Montenegro has continuously been conducting reforms in the area of education and research, while since 2003 in line with the trends in EHEA. After adoption of the Bologna Declaration, University of Montenegro organized systematic preparation of documents aligned with it. Already in 2003, the experimental teaching programme started and today, all studies are organised in line with the Bologna principles. During the last two years systematic reforms of the University`s study programes have been conducted in order to harmonize domestic higher education system with European standards and market needs to highest extent.

The University of Montenegro has unique academic, business and development objectives. It comprises 19 faculties and two research institutes. The seat of the UoM is in Podgorica, the capital city, while university units are located in eight Montenegrin towns. The University support services and centers (advisory services, accounting department, international cooperation, career orientation) are located in the Rectorate.

Academic community of University of Montenegro is aware of the importance of its functioning for further development of the state and wider region. It has been so far, and will be in the future, the leader in processes of social and cultural changes, along with the economic development.

In the aspect of attaining its mission, University of Montenegro is oriented towards the priority social needs of the time in which it accomplishes its mission; open for all the students and staff exclusively based on their knowledge and abilities; dedicated to preservation of multicultural and multi-ethnic society in Montenegro; entrepreneurial in stimulating social and economic application of supreme achievements within the scope of its activities.

In 2015/16 there were a total of 1.192 employees at UoM, 845 of which were engaged in teaching. In the same year there were 20.236 students registered at all three cycles of studies.

Internationalization is high on the agenda of UoM priorities, thus it has participated in a number of international projects – over 50 projects funded under the Tempus programme, over 15 Erasmus Mundus Action 2 projects for student mobility, a number of projects under FP7 funding scheme or IPA supported projects, Erasmus + capacity building and International credit mobility projects and other.

For more information about University of Montenegro, please visit our website www.ucg.ac.me or send e-mail to pr.centar@ac.me.


INTERNATIONAL
SCIENCE CULTURE AND
SPORT ASSOCIATION
www.iscs-a.org


AESA
Asian Exercise and Sport Science Association

CIP – Каталогизација у публикацији
Централна народна библиотека Црне Горе, Цетиње

796:61 (497.16)

MONTENEGRIN journal of sport science and medicine / urednik Duško Bjelica. – Vol. 1, no. 1 (2012) - . – Podgorica (Džordža Vašingtona 445) : Crnogorska sportska akademija, 2013 (Nikšić : Art grafika). – 30 cm

Polugodišnje.
ISSN 1800-8755 = Montenegrin journal of sports science and medicine (Podgorica)
COBISS.CG-ID 17824272

UCG
Univerzitet Crne Gore

Fakultet za sport i fizičko vaspitanje
Univerzitet Crne Gore

Faculty for sport and physical education
N I K Š I Ć

Phone: + 382 40 235 204; Fax: + 382 40 235 207, +382 40 235 200
E-mail: fakultetzasportnk@t-com.me; Web: www.fsnk.ucg.ac.me

Znanje i zdravlje!

MSA Conference 2017

14th International Scientific Conference on Transformation Processes in Sport

UCG
Univerzitet Crne Gore

http://www.csakademija.me/conference/

CRNOGORSKA SPORTSKA AKADEMIJA
MONTENEGRIN SPORTS ACADEMY

SPORT PERFORMANCE

30th March - 2nd April 2017,
Budva - Montenegro