

**JASPE**



ISSN 2536-569X | eISSN 2536-5703

# **Journal of Anthropology of Sport and Physical Education**

[www.jaspe.ac.me](http://www.jaspe.ac.me)



**JANUARY 2020**

**VOL.4  
No.1**





**Journal of Anthropology of Sport  
and Physical Education**

### **Editor-in-Chief**

**Bojan Masanovic** | University of Montenegro, Montenegro

### **Section Editors**

**Radenko Matic** (Cultural Anthropology) | University of Novi Sad, Serbia

**Kubilay Ocal** (Global Anthropology) | Mugla Sitki Kocman University, Turkey

**Dusan Stupar** (Biological Anthropology) | Educons University, Serbia

**Tatjana Jovovic** (Linguistic Anthropology) | University of Montenegro, Montenegro

**Nina Djukanovic** (Medical Anthropology) | University of Belgrade, Serbia

### **Editorial Board**

**Fitim Arifi** | University of Tetova, North Macedonia

**Hassan Sedeghi** | University Putra Malaysia, Malaysia

**Ivana Cerkez Zovko** | University of Mostar, Bosnia and Herzegovina

**Izet Bajramovic** | University of Sarajevo, Bosnia and Herzegovina

**Juel Jarani** | Sports university of Tirana, Albania

**Luiz Fernando Rojo** | Universidade Federal Fluminense, Brazil

**Marin Corluka** | University of Mostar, Bosnia and Herzegovina

**Marko Aleksandrovic** | University of Nis, Serbia

**Sami Sermakhaj** | Universi College, Kosovo

**Stefan Seman** | University of Belgrade, Serbia

**Taher Afsharnezhad** | Shomal University, Iran

**Tonci Bavcevic** | University of Split, Croatia

### **Index Coverage**

DOAJ; Index Copernicus; Google Scholar; Crossref; ROAD

### **Proofreading Service**

**Kristina Perovic Mijatovic**

### **Prepress**

**Milicko Ceranic**

### **Print**

**Art Grafika** | Niksic

### **Print run**

1500

# **MontenegroSport**



**JOURNAL OF ANTHROPOLOGY OF SPORT  
AND PHYSICAL EDUCATION**  
International Scientific Journal

Vol. 4(2020), No. 1 (1-71)

TABLE OF CONTENTS

Petra Zaletel (Original Scientific Paper) <b>A Time Motion and Analysis of Partnering Skills in Latin-American Dance Using a Semi-Automatic Tracking System: A Case Study .....</b>	3-8
Bojan Masanovic, Velisa Vukasevic (Original Scientific Paper) <b>Differences in Anthropometric Characteristics between Junior Handball and Volleyball Players .....</b>	9-14
Sercan Acar, Basak Koca Ozer (Original Scientific Paper) <b>Assessment of The Relationships between Physical and Motor Features of Young Wrestlers from Turkey .....</b>	15-24
Boris Banjević (Original Scientific Paper) <b>Morphological and Functional Characteristics of Army Recruits and Professional Soldiers of Montenegro Armed Forces .....</b>	25-32
Jovan Gardasevic, Dusko Bjelica, Ivan Vasiljevic, Marin Corluka (Original Scientific Paper) <b>Body Composition of Soccer Players of Montenegro and Bosnia and Herzegovina .....</b>	33-38
Ahmed Abdellatif, Badriya Al-Hadabi (Original Scientific Paper) <b>Relationships Between Some Morphological Characteristics and the Body Mass Index and the Distance Achieved in Shot Put .....</b>	39-42
Milena Mitrovic, Katarina Dragutinovic (Original Scientific Paper) <b>Comparative Analysis of Anthropometric Parameters as Obesity Indicators for 7-8 Years-old Children of Different Resident Status .....</b>	43-46
Dragan Bacovic (Original Scientific Paper) <b>Analysis of Obesity and Differences in Nutritional Status of School Children in Central and Southern Region of Montenegro.....</b>	47-50
Miljan Hadzovic, Predrag Ilic, Ana Lilic, Mima Stankovic (Review Paper) <b>The Effects of a Knee Joint Injury Prevention Program on Young Female Basketball Players: A Systematic Review.....</b>	51-56

Juel Jarani (Short Report)	
<b>Report of the International Conference in Sport Science “ICSS 2019” of the Sports University of Tirana.....</b>	<b>57-60</b>
Guidelines for the Authors.....	61 -71

**Full-text available free of charge at <http://www.jaspe.ac.me/>**

**ORIGINAL SCIENTIFIC PAPER**

# A Time Motion and Analysis of Partnering Skills in Latin-American Dance Using a Semi-Automatic Tracking System: A Case Study

Petra Zaletel<sup>1</sup><sup>1</sup>University of Ljubljana, Faculty of Sport, Ljubljana, Slovenia**Abstract**

The aim of the research was analysing motion and partnering skills by examining different relation positions between dance partners, distance covered and speed of movement in Latin-American dance. The sample consisted of three elite Latin-American dance couples simultaneously danced each of five Latin dances consecutively. Dances were recorded using two cameras - first was used to determine the path of the dancers' movement (secured to the ceiling of the hall), the second camera was located on the side of the dance floor to facilitate annotation of the dancers' posture relationships. The overhead footage was later transferred to a PC and analysed with the tracking system. With a specifically designed annotation system we categorised five different relationship postures exhibited between male and female dancers. We used two-way ANOVA for establishing differences in motion regarding gender and different dances. Results showed no differences between gender, but significant differences in speed and distance covered between dances. Samba and Passodoble seemed to be the most dynamic dances, with longest distance covered and highest speed of movement, followed by Cha Cha and Jive whereas activity in the Rumba took place in a relatively small area of the dance floor. Dancers were in open positions 99% of the time (except Passodoble – 87% and Cha Cha – 91%), either touching or not touching each other, with focus on the partner evident between 40% and 60% of the time in all dances. These findings tended to confirm rather than dispute the apriori expectations of individual dance choreographies.

**Keywords:** Sport Dance, Choreography, Positional Relationships, Motion Analysis

**Introduction**

Sport dance consists of five standard (Slow waltz, Viennese waltz, Tango, Foxtrot and Quickstep) and five Latin American dances (Samba, Cha Cha, Rumba, Passodoble and Jive) with couples competing in a combination of all ten dances or in each group (standard or Latin American) separately. These dances are complex and require fine motor skills to exhibit "virtuosic control of body movement in a specific rhythm and space" (Da Silva & Bonorino, 2008). Dance is a sequence of "gestures, steps and movements with musical rhythm that express affectionate states" and also expresses "emotions through physical move-

ment" (Dantas, 1999). Laban (1963) considered dance as a communication tool and tried to extract parameters which could be related to the dance's expressive power.

The duration of each Latin American dance varies from 90 to 120sec consisting of numerous movement structures involving different steps, turns, rapid changes of movement direction and elements of balance, which all require strength and flexibility (Lukić, Bijelić, Zagorc, & Šebić, 2011). Dancesport is in the very heavy to extremely heavy category in energy expenditure (mean heart rate: male  $175.2 \pm 10.7$ , female  $178.6 \pm 8.6$  bpm) and utilizes both aerobic and anaerobic energy systems (McCabe,

---

Correspondence:

**Montenegro Sport** Petra Zaletel,  
University of Ljubljana, Faculty of Sport, Gortanova 22, 1000 Ljubljana, Slovenia  
e-mail: petra.zaletel@fsp.uni-lj.si

Wyon, Ambegaonkar, & Reeding, 2013). During training heart rates as high as 178bpm in Cha Cha, 182bpm in Passodoble and 187bpm in Jive have been recorded indicating that Latin-American dance is a high intensity activity with anaerobic metabolic demands (Zagorc, Karpljuk, & Friedl, 1999). Additionally, Wyon, Abt, Reeding, Head, & Sharp (2004) found similar results in 16-19 years old dancers. An increased demand placed on the fast glycolytic and aerobic systems has been reported during stage performance and dance training sessions - classes (Wyon et al., 2004).

Previous research in dance motion, using semiautomatic tracking system (Zaletel, Vučković, Rebula, & Zagorc, 2010a), showed that the paths of male and female standard dancers were almost identical as opposed to Latin-American dance. A subsequent study that compared high level adult and youth standard dancers showed that the dynamics of movement (distance covered and speed) were greater in the adult couples (Zaletel, Vučković, James, Rebula, & Zagorc, 2010b). The authors suggested that the younger dancers were using a basic choreography travelling in circles while the adult couples used more complex choreographies, consistently utilising the inner space of the dance floor (Prosen, James, Dimitriou, Perš, & Vučković, 2013).

Time and space are two essential components that contribute to the dancer's expressiveness (Minvielle-Moncla, Audefren, Macar, & Vallet, 2008). Precision, accuracy and synchrony in movement execution with the implementation and mastering of fine motor skills and dance figures determine fluidity and successful choreography (Vermey, 1994). The dancers/choreographers try to express their feelings and emotions through an "aesthetic expressive movement form" (Vermey, 1994). Although human movement can convey emotional information (Camurri & Ferrentino, 1999), it is impossible to examine these emotional components with large scale motion measurements (Vučković, Perš, James, & Hughes, 2009).

Overall dance performance is judged based on the dancer's technical skills and aesthetic performance (World Dance Sport Federation, 2019). Artistic component includes partnering skills, choreography and presentation. One of the critical parts of the partnering skills are different positions that dance partners adopt.

In Latin-American dance the standard position (as commonly used in standard dances) is referred to as the "closed" position where the female left hand is on the male's right shoulder, her right hand is in his left hand and his right hand is placed on the upper part of her back. Unlike standard dance this position is not as commonly used and dancers adopt other positions which are referred to as the "open" position. Within this open position the male and female dancer can either touch or not touch each other. Dance partners can be often apart and facing away from each other which results in difficulty for synchronization and coordination of their overall dance performance. As they dance together, female and male dancer are in certain relation with their bodies to each other.

Previous research has suggested that in standard dance the speed and distance covered by dancers is most likely to be due to the choreography (Zaletel et al., 2010b) and also due to different level of performance – better couples are faster and travel further distance (Prosen, 2013), but this remains to be determined through motion analysis in Latin-American dance. To authors knowledge partnering skills in Latin-American dance was not often investigated in sports science. Consequently, a reductionist approach was used in this study which focused on analysing partnering skills by examining different positions between dance partners, distance covered and speed of movement.

## Methods

### Participants

Three elite internationally ranked Latin-American dance couples volunteered to participate in this study. In average three male dancers were 23.8 ( $\pm 2.2$ ) years old, 181.3cm ( $\pm 2.2$ ) high and they weighted 70.2kg ( $\pm 1.6$ ). Their female partners were 21.5 years old ( $\pm 3.6$ ), 165.7m ( $\pm 6.6$ ) high and they weighted in average 55.3kg ( $\pm 5.9$ ). Their average time of training per week was 22.5h ( $\pm 4.5$ ). All dance couples had reached the finals of WDSF International Open competitions in 2017. The study was approved from the authors' University Ethics committee.

### Procedures

All couples simultaneously danced each of five LA dances consecutively, with each dance lasting 90 seconds and a pause of 30 seconds between each dance, as is usual for competitions (World Dance Sport Federation, 2019). Dances were recorded directly to DVD using two cameras (Ultrak KC CCD Color CP 7501, Japan) recording at a frequency of 25 frames per second. The first camera was used to determine the path of the dancers' movement and was secured to the ceiling of the hall which enabled the recording of a rectangular projection on the dance area (20x20m). By using a wide-angle lens (Ultrak KL2814IS, Japan) the entire dance area was in view. A second camera was located on the side of the dance floor to facilitate annotation of the details of the dancers' posture relationships.

The footage was transferred to a PC post event and analysed with a semi-automated tracking system, which is a large scale human tracking motion measurement system based on computer vision technology (Perš, Bon, Kovačić, Šibila, & Dežman, 2002). The system proved to be suitable for analysing dancers' motion in LA and BR dance (Prosen et al., 2013).

### Sample of variables

Preston-Dunlop (1981) listed the basic structures of positions in partnering skills, in development from first to the last: (1) aware of, focus, addressing, (2) near to, proximity, close but not touching, (3) touching, (4) supporting, taking some weight, (5) surrendering, without touch, (6) surrendering with touch, linking, embracing and (7) carrying, holding, lifting. Because of difficulties in following some elements in dance performance (turns are made within part of a second – which means small part of a second dance partners are in open position without focus and touching each other, another short moment at the end of turn they're already in closed position) we made it more simple and clear. So, we adapted the above structure by joining some of them into 5 positions: (1) open position relationship touching each other and focus on partner, (2) open position relationship touching each other without focus, (3) closed position relationship, (4) open position without touching with focus on partner and (5) open position without touching and without focus.

### Data analysis

Descriptive statistics was used for analysing distance covered and speed of movement within each LA dance. Two-way ANOVA was used to establish differences in speed and distance covered between different gender (male and female dancers) and between different Latin-American dance. Descriptive statistics was also used for analysing different proportions of each relationship position between female and male dancer in each LA dance.

## Results

A two-way ANOVA (dance and with repeated measures for gender) found no significant interaction or main effect for differences in average speed between genders (Table 1). However

significant differences between dances were found (Table 3). Results revealed that the Rumba had the lowest average speed,

Cha Cha and Jive were much faster but still slower than Samba and Passadouble.

**Table 1.** Average speeds (m. s-1) in all 5 LA dances and differences in speed between gender

	1st couple		2nd couple		3rd couple		Average speed		F	p
	Male	Female	Male	Female	Male	Female	All males Mean (SD)	All females Mean (SD)		
Samba	0.81	0.80	0.91	0.73	0.95	0.78	0.89 (0.51)	0.77 (0.13)	6.646	0.061
Cha Cha	0.67	0.65	0.63	0.66	0.61	0.63	0.64 (0.02)	0.64 (0.02)	0.257	0.639
Rumba	0.53	0.66	0.54	0.44	0.57	0.51	0.55 (0.02)	0.54 (0.07)	0.023	0.887
Passodoble	0.88	0.83	0.89	0.84	0.80	0.86	0.85 (0.03)	0.84 (0.03)	0.200	0.678
Jive	0.66	0.66	0.68	0.67	0.73	0.59	0.69 (0.03)	0.64 (0.05)	2.344	0.201

Note: F - test difference, p - statistical significance; Mean – average value; SD – standard deviation

A two-way ANOVA (dance and gender) found no significant interaction or main effect for differences in distance covered between genders (Table 2). Howev-

er significant differences between dances were found (Table 3). Rumba had the lowest distance covered, Cha Cha and Jive greater distance but still less distance than Samba and Passadouble.

**Table 2.** Distance (m) covered in all 5 LA dances and differences in distance between gender

	1st couple		2nd couple		3rd couple		Average distance		F	p
	Male	Female	Male	Female	Male	Female	All males Mean (SD)	All females Mean (SD)		
Samba	74.18	73.70	83.59	67.40	87.74	71.90	81.84 (5.3)	71.0 (2.4)	5.991	0.071
Cha Cha	60.06	57.42	55.99	59.07	54.24	56.05	56.76 (2.7)	57.51 (1.3)	0.151	0.718
Rumba	43.85	54.50	44.58	36.45	46.92	42.54	45.12 (1.2)	44.50 (6.7)	0.013	0.914
Passodoble	76.31	72.30	77.30	73.42	69.24	75.14	74.28 (3.3)	73.62 (1.1)	0.062	0.816
Jive	58.57	58.42	60.09	59.32	65.27	52.53	61.31 (2.7)	56.76 (2.9)	2.398	0.196

**Table 3.** Differences in average speed and distance between different dances

	Samba Mean	Cha Cha Mean	Rumba Mean	Passodoble Mean	Jive Mean	F	p
Speed	0.83	0.64	0.55	0.85	0.69	32.675	0.000*
Distance	76.42	57.14	44.81	73.95	59.04	41.183	0.000*

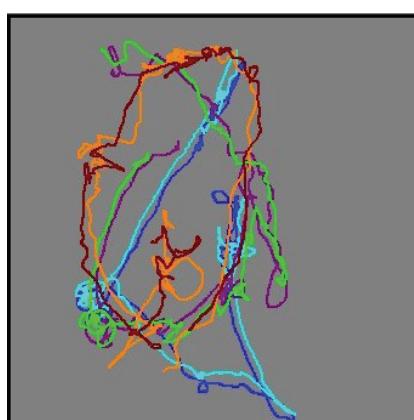
Note: Mean – average value; F - test difference, p - statistical significance, \* - statistical significance ( $p < 0.01$ )

The highest mean speed and the greatest distances covered by dancers were in Samba and Passodoble (Tables 1 and 2) as shown by the paths followed by the couples in this study (Figures 1 and 2).

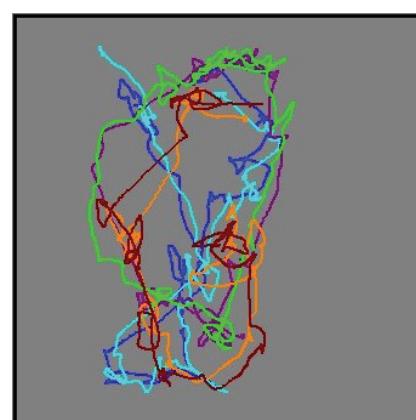
Cha Cha, Jive and Rumba were characterised by relatively stationary dances (Figures 3 – 5) where each dance couple occupied their own space on the dance floor. Dancing couples tended to have very similar mean speeds and paths. However, in Samba male dancers travelled greater distances and at a higher speed,

compared to their female partners (Tables 1 and 2).

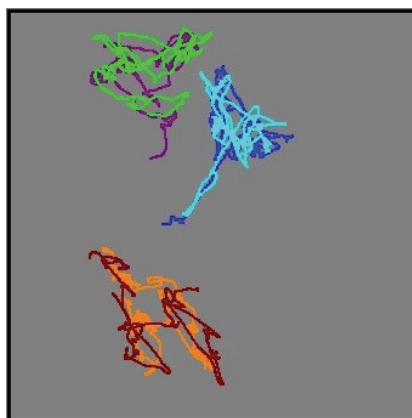
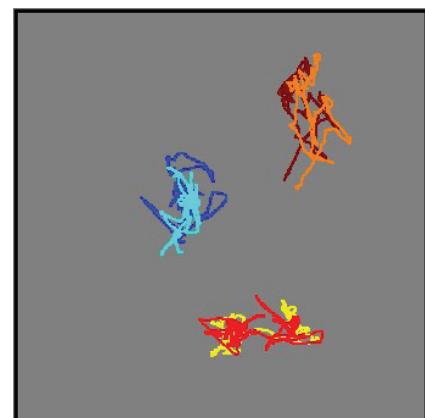
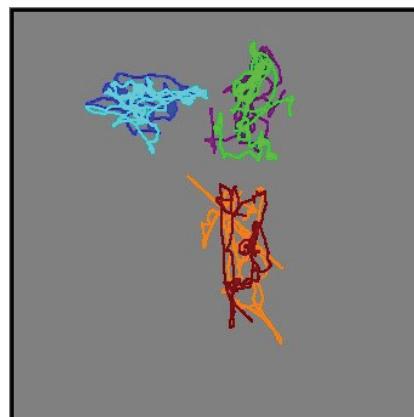
In comparison to Samba and Passodoble, dancers in Cha Cha, Rumba and Jive tended to dance in their own, relatively small space on the dance floor which was not the classical circle manner (Figures 3 – 5). Dance paths in Cha Cha (Fig. 3) and Jive (Fig. 5) showed slightly more movement in comparison to Rumba (Fig. 4) where there was about 23% less distance covered in comparison to the other two dances (Table 2).



**Figure 1.** Trajectories of three dance couples in Samba



**Figure 2.** Trajectories of three dance couples in Passodoble

**Figure 3.** Trajectories of three dance couples in Cha Cha**Figure 4.** Trajectories of three dance couples in Rumba**Figure 5.** Trajectories of three dance couples in Jive

There were different amounts of time spent at each different relationship posture between dance partners in each dance (Table 4). The closed position was the most similar between dances as it was seldom used in Samba, Rumba and Jive (1%) although slightly more in Passodoble (13%) and Cha Cha (9%). The differences between couples in the same dance, was seen to vary between similar proportions in Jive (e.g. open relationship, no touching and no focus on partner in Jive had a mean proportion of 30.3% + 2.44%) to relatively large differences in Cha Cha (e.g. open relationship, touching and no focus on partner in Cha Cha had an average proportion of 17.93%+15.70%), showing the occurrence of between

couple differences in dance interpretation and choreography.

In Samba dancers spent most of the time (37,63%+7,08%) in an open relationship, touching each other, without focus on their partner. Also, around 45% of their time was spent in the open position without touching each other, either focusing on or away from their partner. In Cha Cha 45% of the time was spent in the open position relationship either holding or not holding each other, while in Rumba (70%) and Jive (60%) dancers spent far more time touching each other regardless of the focus in the open relation. Focus on the partner was noticed around 40-60% in all dances, except the Jive, where 63% of the focus was away from the partner.

**Table 4.** Percentage of time spent in each relationship for all five LA dances

Position relationship, touch, focus	Samba Mean (SD)	Cha Cha Mean (SD)	Rumba Mean (SD)	Passodoble Mean (SD)	Jive Mean (SD)
1. Open, touching and focus on partner	15.23 (3.16)	27.43 (12.30)	37.37 (8.30)	17.70 (10.43)	33.53 (5.71)
2. Open, touching no focus	37.63 (7.08)	17.93 (15.70)	29.33 (5.10)	18.27 (3.09)	24.90 (8.30)
3. Closed	1.03 (1.79)	9.40 (4.86)	1.00 (1.73)	13.57 (5.65)	0.70 (1.21)
4. Open, no touching and focus on partner	21.50 (5.08)	35.27 (20.16)	18.67 (2.45)	37.87 (5.00)	10.63 (9.73)
5. Open, no touching and no focus	24.53 (9.05)	9.90 (10.11)	13.67 (8.04)	12.57 (13.04)	30.30 (2.44)

Note: Mean – average value; SD – standard deviation

## Discussion

We analysed some aspects of internationally excellent dance couples' choreographies; motion aspects gave us information

about their paths and speed – which was more depending on music rhythm, specific for each LA dance, and relationship aspects between female and male dancer, which seems to define the con-

tent of each dance. In other words, LA dancers are trying to express, with their movement and choreography, the content of each dance, which seems to be defined by the relationship between the female and male dancer.

The speed of dance movement is an important mechanism for creating the typical expressive movements associated with each LA dance and is determined by the speed of the music (Hoekelmann, 2001). Different tempos and beats help the dancers to create different moods-expressions within the dance choreography. Distances (paths) of each LA dance differed due to different choreographies, which are determined with certain movement structures specific for each dance. In comparison to Samba and Passodoble, paths in Cha Cha, Rumba and Jive took place on smaller space on the dance floor which was not in the shape of classical dance circle. Individual differences were apparent, for example especially in Samba and Jive the distance and speed of male and female dancer differed, but this was probably due to different use of choreography elements; for example when one of the dancers was standing on the spot in Rumba and gesticulating with his/her arms or doing a pose, the other dancer was moving away from or towards her/him, he/she could be spinning around dance partner and their speed and distance was therefore different. That was also the case in Samba, where male dancers had higher speeds and distances than their female partners, probably because males were traveling many times around females, while females were either turning or dancing on the spot. Indeed, this had been found previously (Zaletel et al., 2010b) and is not unusual for some dances as couples often create different paths on the dance floor.

The question remains as to whether these speed and distance measures are significant factors in dance performance.

Samba and Passodoble were the most dynamic dances, with the greatest distance covered and the highest speed of movement. The movement paths in Passodoble reflected the use of a circular direction in space, with sharper changes of movement directions than in Samba where paths were more circled and curved. These results partly agree with the work of Komora (2002) and Štiavnický (2004) who found that fast changes in direction characterised movement patterns during competition LA dances. Paths in Samba also showed relative equality between the partners, confirmed by the similar distances and speeds found for couples. Paths in Samba showed movement in a relatively large circular space, as they would try to exhibit smoothness of movement. These results are in concurrence with the findings of a previous study of physical loads in Latin-American dances (Zaletel et al., 2010a).

The lowest speeds were found in Rumba, probably because dancers were moving around the centre of their own relatively small space rather than the whole of the dance floor. The emphasis for this dance tends to be on body lines and forms using different dynamics in the choreography (Vermey, 1994). The lower speed in the Rumba is thought to facilitate more virtuosic execution (Vermey, 1994). Zaletel et al. (2010a) showed that less experienced dance couples (youth) had higher mean speeds in Rumba than more experienced Adult couples suggesting that speed is related to expertise for this dance. Cha Cha and Rumba have a similar rhythmic structure, where faster Cha Cha has a more playful character, but slower Rumba is a dance with a distinctive character of seduction (Vermey, 1994). Dancing couples tended to have very similar mean speeds and paths in Cha Cha and Rumba which suggests that the choreography is dance specific and maintain some form of relationship between the dance couple. In the Cha Cha emphasis was probably on the legs and feet; on "stepping" which results in the action gestures of the legs and transferring the weight. Dancers had similar speeds in Cha Cha and Jive, which was seen to be an extremely fast and bouncy dance, where the greatest importance was probably gesturing.

Most of the time LA dances were performed in open positions (around 99% of time in Samba, Rumba and Jive and 87-90% in Cha Cha and Passodoble). This may suggest, in agreement with Vermey (1994), that dance partners are creating stereotypical non-verbal gender specific behaviour, where the male initiates actions and has less flow in the movement but high energy with sudden, strong, direct moves while the female is more reactive, with more flowing movements and lower energy.

The major position in Samba (open position, touching each other, without focus – 38%) confirmed that the basic figure in Samba travelled through space, emphasized not the action of travelling, but the zig-zag floor patterns which served to give parading quality of the Samba. Circling in space while travelling or remaining on the spot, was a recurrent spatial structure, which took the focus off the dance partners.

Whilst male LA dancers have been shown to use more focus than females (Vermey, 1994) it was clear in this study that Cha Cha was the dance with most focus between dance partners, dancers were seen to distance themselves before coming close to each other and vice versa throughout the dance. The couples moved in opposite and shared directions as they were non-verbally communicating through their dance. Dancers touched each other most often in the Rumba (67%) probably to promote the act of seduction. Similarly, 60% of the time was spent touching each other in Jive, with focus on and off the partner. Less touching of dance partners was obvious in Samba probably due to the many rotation elements of both dancers. The relatively high incidence of the closed position in Passodoble (13%) seemed to help present a square structure of the dance posture relationship and created a spatial tension between partners and thus gave a stronger appearance.

While dancing the man and woman get in close physical contact, through which a special and intimate relationship is formed between them (Vermey, 1994). Rumba and Cha Cha seemed to have the most focus between the partners either touching or not touching each other, probably because they were creating flirting, seducing moments. Probably focus between dance partners is creating more sincere relationship, which appears to viewer more emotional and has therefore better impact on the audience (and judges). The sincerity of the relationship is probably different between dances due to the characteristics of each dance. In Jive one could say that the dancers were more communicating with audience, perhaps accounting for the fact that for more than half of the time they don't look at each other (55%). Anyway, all these dramatic movements e.g. hip actions, transferring the weight through the feet, wrapping and rotation actions were not well tracked by SAGIT and therefore not analysed.

Artistic component of dance couple is mostly expressed by their relationship positions in choreography, which helps to create content and character of the dance, expressed through the dancer's presentation (Vermey, 1994).

In order to create the character or qualities so essential to each of the five dances, the dancers in this study displayed very different positional relationships as well as paths of their choreography and speed of movement in each LA dance. It seems sensible, therefore, to suggest that future research annotates the small movements or gestures with hands, head etc., to determine not just frequency of these elements but also the sequence of their occurrence, what would give us even more exact (»deeper«) look into individual LA choreography. It would be interesting to compare structures of choreographies and percentage of postures in each LA dance with the judges' results from a dance competition. This would give us some information about the importance of dance choreography characteristics. Findings of this study could serve as template in process of creating elite dance performance.

So, future studies still need to annotate the technical elements in more detail to better understand the choreography. With larger samples this may lead to a better understanding of choreography and the determining factors of successful dance performance.

#### Acknowledgements

There are no acknowledgements.

#### Conflict of Interest

The authors declare that there are no conflicts of interest.

**Received:** 10 November 2019 | **Accepted:** 3 December 2019 | **Published:** 10 January 2020

#### References

- Camurri, A., & Ferrentino, P. (1999). Interactive environments for music and multimedia. *Multimedia Systems*, 7(1), 32–47. doi:10.1007/s005300050109
- Da Silva, A.H., & Bonorino, K.C. (2008). BMI and flexibility in ballerinas of contemporary dance and classical ballet. *Fitness & Performance Journal*, 7(1), 48-51.
- Dantas, E.H.M. (1999). *Flexibilidade: alongamento e flexionamento*. Rio de Janeiro: Shape.
- Hoekelmann, A. (2001). Movement formation under the conditions of improvisation and choreography. *Acta Kinesiologiae Universitatis Tartuensis*, 6, 120-123.
- Komora, J. (2002). *Technique of Latin-American dances*. Bratislava: SZTŠ.
- Laban, R. (1963). *Modern Educational Dance*. Suffolk: The Chaucer Press Ltd.
- Lukić A.L., Bijelic, S., Zagorc, M., & Šebić, L. (2011). The importance of strength in sport dance performance technique. *SportLogia*, 7(1), 61–67.
- McCabe, T.R., Wyon, M., Ambegaonkar, J. P., & Redding, E. (2013). A bibliographic review of medicine and science research in Dance Sport. *Medical problems of performing artists*, 28(2), 70-79.
- Minvielle-Moncla, J., Audiffren, M., Macar, F., & Vallet, C. (2008). Overproduction timing errors in expert dancers. *Journal of Motor Behaviour*, 40(4), 291-300.
- Perš, J., Bon, M., Kovačič, S., Šibila, M., & Dežman, B. (2002). Observation and analysis of large-scale human motion. *Human Movement Science*, 21, 295-311.
- Preston-Dunlop, V. (1981). *The nature of the Embodiment of Choreutic Units in Contemporary Choreography*. London: Laban Center for Movement and Dance.
- Prosen J., James, N., Dimitriou, L., Perš, J., & Vučković, G. (2013). A Time-Motion Analysis of Turns Performed by Highly Ranked Viennese Waltz Dancers. *Journal of Human Kinetics*, 37(1), 55-62.
- Štiavnický, M. (2004) *Evaluation guidelines in dance sport*. Bratislava: SZTŠ
- Streškova, E., & Chren, M. (2009). Balance ability level and sport performance in Latin-American dances. *Physical Education and Sport*, 7(1), 91-99.
- Vermey, R. (1994). Latin. *Thinking, sensing and doing in latin american dancing*. Trento: Kastell Verlag.
- Vučković, G., Perš, J., James, N., & Hughes, M. (2009). Tactical use of the T area in squash by players of differing standard. *Journal of Sport Science*, 27(8), 863 – 871.
- World Dance Sport Federation. (2019, September 15). WDSF Competition rules. Retrieved from World Dance Sport Federation website: <https://www.worlddancesport.org/Rule/Competition/General>
- Wyon, M. A., Abt, G., Redding, E., Head, A., Sharp, C. (2004). Oxygen Uptake During Modern Dance Class, Rehearsal, and Performance. *Journal of Strength and Conditioning Research*, 18(3), 646–649.
- Zagorc, M., Karpljuk, D., & Friedl, M. (1999). *Analysis of functional strain in top sports dancers*. D. Milanović, Ed., Collection of works "Kinesiology for 21st century", Zagreb: University of Zagreb, Faculty of Physical Culture, 240-244.
- Zaletel, P., Vučković, G., James, N., Rebula, A., & Zagorc, M. (2010b). A time-motion analysis of ballroom dancers using an automatic tracking system. *Kinesiologica Slovenica*, 16(3), 46-56.
- Zaletel, P., Vučković, G., Rebula, A., & Zagorc, M. (2010a). Analiza obremenitve plesnih parov pri izbranih standardnih in latinskoameriških plesih s pomočjo sledilnega sistema SAGIT [Analysis of dance couples' loading during selected ballroom and Latin-American dances using the SAGIT tracking system]. *Šport*, 58(3-4), 85-91.

**ORIGINAL SCIENTIFIC PAPER**

# Differences in Anthropometric Characteristics between Junior Handball and Volleyball Players

Bojan Masanovic<sup>1</sup>, Velisa Vukasevic<sup>2</sup><sup>1</sup>University of Montenegro, Faculty for Sport and Physical Education, Niksic, Montenegro, <sup>2</sup>Basketball Club Vizura, Belgrade, Serbia**Abstract**

The purpose of this study was to describe anthropometric characteristics of junior handball and volleyball players from the Serbian National League as well as to make a comparison between them. 61 male athletes were enrolled in this study, divided into three groups: 15 handball players, 14 volleyball players and 32 healthy sedentary subjects. The variables sample included 20 anthropometric measures that defined longitudinal and transversal dimensionality of skeleton, volume and mass of the body, and subcutaneous adipose tissue. The descriptive statistics were expressed as a mean (SD) for each variable, while the ANOVA and the LSD Post Hoc tests were carried out to detect differences between group. The results showed that a significant difference was found in variables body height, body weight, elbow diameter, thigh skinfold, calf skinfold, but no significant difference was found in the remaining 15 variables. Therefore, these findings may give coaches from the region better working knowledge and suggest to them to follow recent selection process methods and to be more careful during the process of talent identification.

**Keywords:** Morphological Characteristics, Different Sports Activity, Comparison, Male Athletes

**Introduction**

Optimal biomechanical and physiological capacity is necessary if the athlete wants to be competitive at the professional level (Bozic & Berjan Bacvarevic, 2018; Coh, Zvan, Boncina, & Stuhec, 2019). Logically, from junior athletes who are competing in top leagues are expected to have optimal morphological characteristics and motor abilities for the functional requirements of the sport in question (Jaksic, Lilic, Popovic, Matic, & Molnar, 2014; Sermakhaj, Popovic, Bjelica, Gardasevic, & Arifi, 2017; Gardasevic, Akpinar, Popovic, & Bjelica, 2019). Although it is very important increasing the physical fitness of athletes, without taking into consideration the assessment of their body composition and their nutritional status we will not be able to reach the top result (Vasiljević, Bjelica, Popović, & Gardašević, 2015; Gardasevic & Bjelica, 2020). It's well known that specific anthropometric characteristics are significantly associated with sports results, and that absolute size contributes to a significant percentage of the total variance associated with sports results, therefore contemporary sport science is designed to identify talents as

precisely and as early as possible (Akpinar, Zileli, Şenyüzlü, & Tunca, 2012; Masanovic, 2018). However, talent identification is very demanding so we have to be very careful, mostly due to the reason that the pace of growth and development is an individual characteristic (Matthys et al., 2011; Popovic, Bjelica, Jaksic, & Hadzic, 2014), some children later reach maximum body height, and some athletes compensate for their lower morphological predisposition by psychophysical ability (Vila Suarez, Ferragut, Alcaraz, Rodriguez Suarez, & Cruz Martinez, 2008; Rexhepi & Bretovcic, 2010).

The characteristics of the activities that handball players perform during training and matches are different from those of volleyball. Handball is a game that contains physical contact, requires great durability and strength and it is considered as one of the fastest team sports (Bilge, 2013; Bjelica, Popovic, & Gardasevic, 2016; Gusic, Popovic, Molnar, Masanovic, & Radakovic, 2017). Consist specific manoeuvres such as jumping, pressurizing, blocking and shooting on goal. On the other hand, there is no contact in volleyball because two teams of six players are separated by a net. In this

Correspondence:

**Montenegro  
Sport**

B. Masanovic  
University of Montenegro, Faculty for Sport and Physical Education, Narodne omladine bb, Niksic, Montenegro  
E-mail: bojanma@ucg.ac.me

game, movement patterns significantly differ from those in handball, this game includes a large number of spiking, jumping, power hitting, blocking, and setting that is mainly based on a high level of strength and power (Palao, Lopez-Martinez, Valades, & Hernandez, 2019; Marques, & Marinho, 2009).

Many researchers have hypothesized that athletes in training might be expected to exhibit structural and functional characteristics that are specifically favourable to sports they play (Pojiskic, Separovic, Muratovic, & Uzicanin, 2014; Monson, Brasil, & Hluskova, 2018). Therefore, changes in the body structure of handball and volleyball players are expected, so that they can complete the requirements of the activity in an effective manner (Massuca & Fragoso, 2011). It is evident a lack of data from Eastern Europe, especially the Western Balkan region considering that most of the descriptive data concerning characteristics of handball and volleyball players come from America and Western Europe. Therefore, it is necessary to extend the data collected and increase knowledge regarding the anthropometric characteristics of athletes from the Western Balkans (Popović, Bjelica, Jakšić, & Hadžić, 2014; Masanovic, Milosevic, & Corluka, 2018).

Hence, the purpose of this study is to describe anthropometric characteristics and body composition profiles of junior handball and volleyball players from the Serbian National League, and to detect possible differences in relation to the competition levels.

## Methods

In this study were enrolled 61 male athletes. They were divided into three groups: 15 handball players ( $16.93 \pm 0.59$  yrs.) from the Serbian Junior Premier League, 14 volleyball players ( $17.36 \pm 0.74$  yrs.) from the Serbian Junior Premier League and 32 healthy sedentary subjects from the same country ( $17.34 \pm 0.60$  yrs.).

Anthropometric research technique was used for data col-

lection. A total of 20 anthropometric measures were evaluated which defined the longitudinal and transversal dimensionality of skeleton, body volume and body mass, and subcutaneous adipose tissue: body height, body weight, elbow diameter, wrist diameter, knee diameter, ankle joint diameter, minimum circumference of the upper arm, maximum circumference of the upper arm, minimum circumference of the forearm, maximum circumference of the forearm, minimum circumference of the upper leg, maximum circumference of the upper leg, minimum circumference of the lower leg, maximum circumference of the lower leg, skinfold thickness of the upper arm, skinfold thickness of the forearm, skinfold thickness of the thigh, skinfold thickness of the calf, skinfold thickness of the chest and skinfold thickness of the abdomen. Anthropometric research was conducted according to IBP standards, while respecting the basic rules and principles related to the selection of parameters, standard conditions and measuring techniques, as well as the standard measuring instruments calibrated before measuring.

The data obtained in the research was processed using the application statistics program SPSS 20.0, (Chicago, IL, USA) adjusted for use on personal computers. The descriptive statistics were expressed as a mean (SD) for each variable. Analysis of variance (ANOVA) and the LSD Post Hoc test were carried out to detect differences between group for each variable. The significance was set at an alpha level of 0.05.

## Results

Anthropometric characteristics of subjects are shown in Table 1. There were significant differences in five out of 20 variables among the groups. Observing the results of the central tendency and dispersion parameters we immediately notice that athletes have better values in 19 variables, while in terms of control group, have better values in only one variable.

**Table 1.** Descriptive data and ANOVA of male athletes enrolled in the study (n=61)

Variables	Handball (n=15)	Volleyball (n=14)	Control (n=32)	ANOVA
	Mean ± Standard Deviation			
Body height (cm)	181.51±5.33	194.28±5.30	178.26±7.26	.000*
Body weight (kg)	74.73±10.17	82.04±8.58	70.27±14.09	.014*
Elbow diameter (mm)	69.95±4.32	75.69±3.85	70.84±3.50	.000*
Wrist diameter (mm)	59.96±6.21	59.69±3.71	58.56±2.89	.481^
Knee diameter (mm)	101.17±7.36	97.81±4.79	99.62±4.30	.242^
Ankle joint diameter (mm)	76.48±6.21	74.00±3.00	73.47±4.28	.116^
Upper arm circumference (min) (cm)	29.17±2.81	28.68±1.88	28.66±3.65	.864^
Upper arm circumference (max) (cm)	31.47±2.92	30.57±1.88	30.16±3.88	.452^
Lower arm circumference (min) (cm)	17.10±1.17	16.82±.70	16.95±1.03	.755^
Lower arm circumference (max) (cm)	25.83±2.03	25.72±1.44	25.84±2.18	.979^
Upper leg circumference (min) (cm)	40.27±3.54	40.90±2.30	39.08±3.90	.235^
Upper leg circumference (max) (cm)	56.53±5.63	56.11±3.36	54.59±6.67	.504^
Lower leg circumference (min) (cm)	23.60±1.45	24.25±2.02	23.14±1.67	.133^
Lower leg circumference (max) (cm)	37.77±2.86	37.46±1.99	36.48±3.22	.307^
Upper arm skinfold (mm)	6.20±1.22	5.29±1.12	7.17±3.82	.125^
Lower arm skinfold (mm)	6.77±1.70	6.21±.90	7.83±3.37	.131^
Thigh skinfold (mm)	14.40±4.27	11.19±3.53	17.20±8.40	.023*
Calf skinfold (mm)	11.60±2.87	7.98±1.58	11.95±4.82	.007*
Chest skinfold (mm)	9.60±3.46	8.39±2.12	11.86±8.34	.205^
Abdomen skinfold (mm)	9.59±4.03	8.38±1.94	11.81±8.75	.248^

Legend: n = number of subjects; ^ = non-significant; \* = significant difference between the groups

**Table 2.** The LSD Post Hoc test for different parameters among the subjects

Dependent Variable	Sport	Sport	Sig	Dependent Variable	Sport	Sport	Sig
Body height	volleyball	control group	.000*	Lower leg circumference (min)	volleyball	control group	.047*
	handball	handball	.000*		handball	handball	.309^
	volleyball	volleyball	.000*		volleyball	volleyball	.047*
	handball	handball	.111^		handball	handball	.393^
	volleyball	volleyball	.000*		handball	volleyball	.309^
	control group	control group	.111^		control group	control group	.393^
Body weight	volleyball	control group	.004*	Upper arm skinfold	volleyball	control group	.047*
	handball	handball	.112^		handball	handball	.400^
	control group	volleyball	.004*		control group	volleyball	.047*
	handball	handball	.246^		handball	handball	.289^
	volleyball	volleyball	.112^		handball	volleyball	.400^
	control group	control group	.246^		control group	control group	.289^
Elbow diameter	volleyball	control group	.000*	Thigh skinfold	volleyball	control group	.007*
	handball	handball	.000*		handball	handball	.202^
	control group	volleyball	.000*		control group	volleyball	.007*
	handball	handball	.453^		handball	handball	.187^
	volleyball	volleyball	.000*		handball	volleyball	.202^
	control group	control group	.453^		control group	control group	.187^
Ankle joint diameter	volleyball	control group	.721^	Calf skinfold	volleyball	control group	.002*
	handball	handball	.152^		handball	handball	.014*
	control group	volleyball	.721^		control group	volleyball	.002*
	handball	handball	.041*		handball	handball	.773^
	volleyball	volleyball	.152^		handball	volleyball	.014*
	control group	control group	.041*		control group	control group	.773^

Legend: Sig - significance of two-tailed testing of arithmetic mean difference; ^ = non-significant; \* = significant  $\leq 0.01$

Significant differences of anthropometric characteristics among particular sports are shown in Table 2. The LSD Post Hoc test indicated that volleyball players were significantly taller than handball players and subjects from the control group. Volleyball players were significantly heavier than subjects from the control group. Also, volleyball players have significantly higher value of elbow diameter than handball players and subjects from the control group. Subjects from the control group have significantly lower value of ankle joint diameter than handball players and significantly lower value of minimum circumference of the lower leg than volleyball players. Also subjects from the control group have significantly higher value of skinfold thickness of the upper arm and skinfold thickness of the thigh than volleyball players. Lastly, subjects from the control group have had the higher value of skinfold thickness of the calf than handball and volleyball players.

## Discussion

Results of this study indicate a strong difference regarding body height among handball and volleyball players on one side and subjects from the control group on the other side which is consistent with previous studies (Taborski, 2007; Lidor & Ziv, 2010). Different type of activity and game rules can explain the observed difference between handball and volleyball players (Masanovic, 2019). However, the worrying fact is that there is no significant difference among handball players and subjects from the control group, because research shows that body height is very important for success in elite handball (Masanovic, Corluka, & Milosevic, 2018). The absence of differences between handball players and subjects from the control group, raises doubts that the selection process has been carried out correctly. This is confirmed by the fact that official statistical data proved that Serbian handball players are shorter than the most successful teams which participated in the IHF Men's Youth World Championship played in Russia 2015. Even teams that were not among the top 10 best ranked teams are significantly higher than Serbian players. For example, the players 13th Korea had an average 183.4 centimetres and 19th Poland had an average 190.1 centimetres. This insight may suggest the coaches from Serbia to be more careful during the talent identification as they have a very tall population in general (Arifi, Bjelica, Sermaxhaj, Gardasevic, Kezunovic, & Popovic, 2017; Popovic, Gardasevic, Masanovic, Arifi, & Bjelica, 2017; Masanovic, Gardasevic, & Arifi, 2018; Gardasevic, 2019). On the other hand, junior volleyball players from the Serbian National League were tall enough and with average body height 194.36 centimetres did not lag behind the top European players. This proves the fact that the average body height of the volleyball teams who played the finishing line CEV U17 Volleyball European Championship 2017 in Turkey were as it follows: Russia (199.1 cm), Belarus (192.44 cm), Greece (187.5 cm), Italy (192.33 cm), Bulgaria (195.84 cm), Netherlands (188 cm). However, this is not a surprise, as it is well-known that the density including very tall subjects appears to be characteristic of people from this area (Western Balkan), since a high percentage of people from general population were measured at 190 cm or more (Bjelica et al., 2012; Pineu, Delamarche, & Bozinovic, 2005; Popovic, Bjelica, Molnar, Jaksic, & Akpinar, 2013a; Masanovic, 2018a; Gardasevic, Masanovic, & Arifi, 2018).

Furthermore, it was expected that volleyball players were heavier than handball players and subjects from the control group, mostly due to the fact they are significantly taller than both groups mentioned. The absence of a significant body mass difference between handball players and subjects from the control group is also a surprise, which again points to mistakes during talent identification.

Results related to measures of the skeleton transversal showed that volleyball players have higher value of elbow diameter than handball players and subjects from the control group, while that handball players have higher value of ankle joint diameter than subjects from the control group. It should be noted that greater differences are expected in favour of volleyball and handball players, because many years of training affect the adaptation of the bone system (Marques et al., 2010). However, as this is a junior age, a more extensive adaptation is expected in the future (Gardasevic, Georgiev, & Bjelica, 2012).

Results related to measures of the body volume do not show a significant difference between athletes and subjects from the control group which was not expected. reason is because increasing muscle mass is important to improve strength and power, relevant to sport performance (Kraemer et al., 2004), and precisely the dimensions of the volume are an indicator of muscle mass. Nevertheless, a review of the descriptive data reveals that six of the eight parameters of athlete circumference have more value than the subjects from the control group. On the other side, increase in muscle mass occurs at the end of the growth phase (Arifi, Bjelica, & Masanovic, 2019), also systematic strength training approaches in the later stages (Balciunas, Stonkus, Abrantes, & Sampaio, 2006), these facts can justify the current situation, so there is no need to worry.

Finally, volleyball players have the lowest value of all skinfolds, for three out of six the difference is statistically significant (upper arm skinfold; thigh skinfold, calf skinfold), which is expected since systematic organized training has the effect of reducing fat mass. In most sports, it is well known that excessive fat mass compromises physical performance (Nikolaidis & Vassilios-Karydis, 2011), therefore in most sports it is undesirable. Hence, the absence of a significant difference in the skinfolds thickness of handball players is a surprise. Therefore, it may be suspected that activities are not of adequate volume and intensity, also that the process of talent identification is not well done. However, it is encouraging that handball players have lower values of all skinfolds than subjects from control group.

The importance of anthropometric characteristics in sport performance is a primary concern in creating athletes profiles as well as conditioning programs throughout a season at all levels of competitions (Silvestre et al., 2006), as describing anthropometric characteristics of athletes and detecting possible differences in relation to competition levels may give coaches a better working knowledge of the studied groups of athletes.

Moreover, the results of this study suggest that volleyball players from this study have anthropometric characteristics that are at the level of the world's leading teams, until the handball players are at such a high level. Morphological characteristics of elite handball and volleyball players appear to be of great interest for some authors (Bayios, Bergeles, Apostolidis, Noutsos, & Koskolou, 2006; Popovic et al., 2014; Barraza et al., 2015; Herdy, Costa, Simão, & Selfe, 2018) with the interest of finding the best morphology somatotype for particular sports, competition levels and player positions as well. Comparison of anthropometrics should support coaches with better understanding of specific demands of certain sport, where particular morphology profile of athlete, combined with motor and functional abilities, should express its full potential (Gusic et al. 2017).

The limitedness of this study is an insufficient sample of respondents which makes it impossible to generalize conclusions, especially if you take into account the unexpected data obtained by measuring handball players, so the next study should include more respondents. This approach could certainly contribute to the quality of the results obtained, and in this way would enable more representative data on the basis of which it would gain

an accurate insight into the social inclusion of young people, but would not reduce the contribution of this preliminary study.

### Acknowledgements

There are no acknowledgements.

### Conflict of Interest

The authors declare that there are no conflicts of interest.

**Received:** 13 August 2019 | **Accepted:** 11 October 2019 | **Published:** 10 January 2020

### References

- Akpınar, S., Zileli, R., Şenyüzlü, E., & Tunca, S. (2012). Predictors Affecting the Ranking in Women Armwrestling Competition. *Montenegrin Journal of Sports Science and Medicine*, 1(1), 11-14.
- Arifi, F., Bjelica, D., & Masanovic, B. (2019). Differences in anthropometric characteristics among junior soccer and handball players. *Sport Mont*, 17(1), 45-49.
- Arifi, F., Bjelica, D., Sermaxhaj, S., Gardasevic, J., Kezunovic, M., & Popovic, S. (2017). Stature and its Estimation Utilizing Arm Span Measurements in Kosovan Adults: National Survey. *International Journal of Morphology*, 35(3), 1161-1167.
- Balciunas, M., Stonkus, S., Abrantes, C., & Sampaio, J. (2006). Long term effects of different training modalities on power, speed, skill and anaerobic capacity in junior male basketball players. *Journal of Sports Science and Medicine*, 5(2), 163-170.
- Barraza, F., Yanez, R., Tuesta, M., Nunez, P., Zamora, Y., & Rosales, G. (2015). Perfil Antropométrico por Posicion de Juego en Handbolistas Chilenos. *International Journal of Morphology*, 33(3), 1093-1101. doi: 10.4067/S0717-95022015000300045
- Bayios, I.A., Bergeles, N.K., Apostolidis, N.G., Noutsos, K.S., & Koskolou, M.D. (2006). Anthropometric, body composition and somatotype differences of Greek elite female basketball, volleyball and handball players. *Journal of Sports Medicine and Physical Fitness*, 46(2), 271-280.
- Bilge, M. (2013). Interval Training Specific to Handball and Training Programme Designs. *World Applied Sciences Journal*, 25(7), 1066-1077.
- Bjelica, D., Popović, S., & Gardašević, J. (2016). Pressure dependence of handball repulsion within this sport. *Journal of Physical Education and Sport*, 16(2), 1078-1083. doi: 10.7752/jpes.2016.s2172
- 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 Notebook*, 18(2), 69-83.
- Bozic, P.R., & Berjan Bacvarevic, B. (2018). Force-velocity profiles of elite athletes tested on a cycle ergometer. *Montenegrin Journal of Sports Science and Medicine*, 7(1), 59-66. doi: 10.26773/mjssm.180308
- Coh, M., Zvan, M., Boncina, N., & Stuhec, S. (2019). Biomechanical model of hurdle clearance in 100m hurdle races: a case study. *Journal of Anthropology of Sport and Physical Education*, 3(4), 3-6. doi: 10.26773/jaspe.191001
- Gardasevic, J. & Bjelica, D. (2020). Body composition differences between football players of the three top football clubs. *International Journal of Morphology*, 38(1), 153-158.
- Gardasevic, J. (2019). Standing height and its estimation utilizing tibia length measurements in adolescents from western region in Kosovo. *International Journal of Morphology*, 37(1), 227-231.
- Gardasevic, J., Akpinar, S., Popovic, S., & Bjelica, D. (2019). Increased Perceptual and Motor Performance of the Arms of Elite Water Polo Players. *Applied Bionics and Biomechanics*, 6763470. doi: 10.1155/2019/6763470.
- Gardašević, J., Georgiev, G., & Bjelica, D. (2012). Qualitative changes of basic motor abilities after completing a six-week training programme. *Acta Kinesiologica*, 6(1), 70-74.
- Gardasevic, J., Masanovic, B., & Arifi, F. (2018). Relationship between tibia length measurements and standing height: A prospective regional study among adolescents in southern region of Kosovo. *Sport Mont*, 16(3), 51-55. doi: 10.26773/smj.181009
- Gusic, M., Popovic, S., Molnar, S., Masanovic, B., & Radakovic, M. (2017). Sport-specific morphology profile: Differences in anthropometric characteristics among elite soccer and handball players. *Sport Mont*, 15(1), 3-6.
- Herdy, C., Costa, P. B., Simão, R., & Selfe, J. (2018). Physiological profile of Brazilian elite handball players: Comparison between U-17, U-20 and professionals. *Journal of Anthropology of Sport and Physical Education*, 2(3), 43-47. doi: 10.26773/jaspe.180708
- Jaksic, D., Lilic, S., Popovic, S., Matic, R., & Molnar, S. (2014). Application of a More Advanced Procedure in Defining Morphological Types. *International Journal of Morphology*, 32(1), 112-118.
- Kraemer, W.J., French, D.N., Paxton, N.J., Häkkinen, K., Volek, J.S., Sebastianelli, W.J., Putukian, M., Newton, R.U., Rubin, M.R., Gómez, A.L., Vescovi, J.D., Ratamess, N.A., Fleck, S.J., Lynch, J.M., & Knutgen, H.G. (2004). Changes in exercise performance and hormonal concentrations over a Big Ten soccer season in starters and nonstarters. *The Journal of Strength & Conditioning Research*, 18(1), 121-128.
- Lidor, R. & Ziv, G. (2010). Physical characteristics and physiological attributes of adolescent volleyball players-a review. *Pediatric Exercise Science*, 22(1), 114-134.
- Marques, E. A., Mota, J., Machado, L., Sousa, F., Coelho, M., Moreira, P., & Carvalho, J. (2010). Multicomponent Training Program with Weight-Bearing Exercises Elicits Favorable Bone Density, Muscle Strength, and Balance Adaptations in Older Women. *Calified Tissue International*, 88(2), 117-129. doi: 10.1007/s00223-010-9437-1
- Marques, M.C. & Marinho, D.A. (2009). Physical parameters and performance values in starters and non-starters volleyball players: A brief research note. *Motricidade*, 5(3), 7-11.
- Masanovic, B. (2018). Comparative study of anthropometric measurement and body composition between junior basketball and volleyball players from Serbian national league. *Sport Mont*, 16(3), 19-24.
- Masanovic, B. (2018a). Standing height and its estimation utilizing arm span and foot length measurements in dinaric alps population: a systematic review. *Sport Mont*, 16(2), 101-106.
- Masanovic, B. (2019). Comparative Study of Morphological Characteristics and Body Composition between Different Team Players from Serbian Junior National League: Soccer, Handball, Basketball and Volleyball. *International Journal of Morphology*, 37(2), 612-619.
- Masanovic, B., Corluka, M., & Milosevic, Z. (2018). Comparative Study of Anthropometric Measurement and Body Composition of Junior Soccer and Handball Players from the Serbian National League. *Kinesiologia Slovenica*, 24(3), 37-46.
- Masanovic, B., Gardasevic, J., & Arifi, F. (2018). Relationship between foot length measurements and standing height: a prospective regional study among adolescents in southern region of Kosovo. *Sport Mont*, 16(2), 27-31. doi: 10.26773/smj.180605
- Masanovic, B., Milosevic, Z., & Corluka, M. (2018). Comparative Study of Anthropometric Measurement and Body Composition between Junior Handball and Volleyball Players from Serbian National League. *International Journal of Applied Exercise Physiology*, 7(4), 1-6. https://doi.org/10.30472/ijaepl.v7i4.313
- Massuça, L., & Fragoso, I. (2011). Study of Portuguese handball players of different playing status. A morphological and biosocial perspective. *Biol. Sport*, 28(1), 37-44.
- Matthys, S.P.J., Vaeyens, R., Vandendriessche, J., Vandorpe, B., Pion, J., Coutts, A.J., Lenoir, M., & Philippaerts, R.M. (2011). A multidisciplinary identification model for youth handball. *European Journal of Sport Science*, 11(5), 355-363. doi: 10.1080/17461391.2010.523850
- Monson, T.A., Brasil, M.F., & Hlusko, L.J. (2018). Allometric variation in modern humans and the relationship between body proportions and elite athletic success. *Journal of Anthropology of Sport and Physical Education*, 2(3), 3-8. doi: 10.26773/jaspe.180701
- Nikolaidis, P.T., & Vassilios Karydis, N. (2011). Physique and body composition in soccer players across adolescence. *Asian Journal of Sports Medicine*, 2(2), 75-82.
- Palao, J. M., Lopez-Martinez, A., Valades, D., & Hernandez, E. (2019). Manner of Execution and Efficacy of Reception in Men's Beach Volleyball. *Montenegrin Journal of Sports Science and Medicine*, 8(2), 21-26. doi: 10.26773/mjssm.190903
- 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.
- Pojskic, H., Separovic, V., Muratovic, M., & Uzicanin, E. (2014). Morphological Differences of Elite Bosnian Basketball Players According to Team Position. *International Journal of Morphology*, 32(2), 690-694.
- Popovic, S., Gardasevic, J., Masanovic, B., Arifi, F., & Bjelica, D. (2017). Standing Height and its Estimation Utilizing Foot Length Measurements in Adolescents from Western Region in Kosovo. *Sport Mont*, 15(3), 3-7.
- Popović, S., Bjelica, D., Jakšić, D., & Hadžić, R. (2014). Comparative Study of Anthropometric Measurement and Body Composition between Elite Soccer and Volleyball Players. *International Journal of Morphology*, 32(1), 267-274.
- Popovic, S., Bjelica, D., Molnar, S., Jaksic, D., & Akpinar, S. (2013a). Body Height and Its Estimation Utilizing Arm Span Measurements in Serbian Adults. *International Journal of Morphology*, 31(1), 271-279.
- Rexhepi, A., & Breštovci, B. (2010). Differences in bodily growth between junior footballers and basketball players. *International Journal of Morphology*, 28(2), 415-420.
- Sermaxhaj, S., Popovic, S., Bjelica, D., Gardasevic, J. & Arifi, F. (2017). Effect of

- recuperation with static stretching in isokinetic force of young football players. *Journal of Physical Education and Sport*, 17(3), 1948-1953. doi: 10.7752/jpes.2017.03191
- Taborsky, F. (2007). *The Body Height and Top Team Handball Players*. Vienna: EHF Web Periodical.
- Vasiljević, I., Bjelica, D., Popović, S., & Gardašević, J. (2015). Analysis of nutrition of preschool-age and younger school-age boys and girls. *Journal of Physical Education and Sport*, 15(3), 426–428. doi:10.7752/jpes.2015.03063
- Vila Suarez, M.H., Ferragut, C., Alcaraz, P.E., Rodríguez Suarez, N., & Cruz Martinez, M. (2008). Anthropometric and strength characteristics in junior handball players by playing positions. *Archivos de Medicina del Deporte*, 125(3), 167-177.

**ORIGINAL SCIENTIFIC PAPER**

# Assessment of The Relationships between Physical and Motor Features of Young Wrestlers from Turkey

Sercan Acar<sup>1</sup>, Basak Koca Ozer<sup>2</sup>

<sup>1</sup>Cumhuriyet University, Faculty of Letters, Department of Anthropology, Sivas, Turkey, <sup>2</sup>Ankara University, Faculty of Languages, History and Geography, Department of Anthropology, Ankara, Turkey

## Abstract

Physical development, fitness and motor skills are the most important components in determining the performance and success of wrestlers, with wrestling largely dependent on overall body strength and relatively short match times. The aim of the present study is to evaluate the relationships between the physical and motor characteristics of young wrestlers in Sivas, Turkey. The study conducted on 86 male freestyle wrestlers aged 10 to 21 years representing urban and rural areas. The sample was analyzed by age groups; 10 to 14 years olds, 15 to 17 years olds and 18 to 21 years olds due to the skill level of the United World Wrestling (UWW) sport categories. Anthropometric measurements (height, weight, skin folds and body composition) as well as motor tests (speed, flexibility and durability) were performed and the data were analyzed using the Statistical Package for Social Science (SPSS) version 23. The results showed that physical properties were correlated significantly with motor features and affected them significantly. According to standardized regression coefficients ( $\beta$ ), particularly muscle mass and free fat mass values were presented significant relationships on the anthropometric characters for all of age groups. As a conclusion, wrestlers from all age groups have presented with high level of fat mass, muscle mass and fat free mass where motor and physical properties are highly correlated among the wrestling athletes in accordance with the special training methods.

**Keywords:** *Wrestling, Physical Properties, Motor Characters, Sivas, Turkey*

## Introduction

During the last century, increasing the value attached to sport in the world, and especially in Turkey, has led to young people exercising in different areas. The role of climate and environmental conditions can not be denied among the reasons why people prefer sports. However, the physical structure, performance, motor characteristics and body composition of the individual are also important. Furthermore, recognizing skillful and intelligent athletes are currently one of the most important and striking issues in sport. In other words, the identification, training and evaluation of talented athletes discovered early on prepare them for

their future success (Jafari, Damirchi, Mirzaei, & Nobari, 2016). One of the sports that should start at an early age is wrestling. Wrestling is one of the oldest combat sports and dates back to 708 BC to the ancient Greek Olympic Games. Today, there are two types of wrestling on the international platform known as Greco-Roman wrestling and freestyle wrestling. Greco-Roman wrestlers can use the upper body only for attack, and it is forbidden to hold them under the waist. However, in freestyle wrestling they are allowed to use their entire body during the competition (Chaabene et al., 2016).

Any sport that is exercised and match within a short peri-

---

Correspondence:

**Montenegro Sport**

S. Acar

Cumhuriyet University, Faculty of Letters, Department of Anthropology, 58100 City Center, Sivas, Turkey

E-mail: sercanacar@ankara.edu.tr

od of time, requires high level of total body strength (Cicioğlu, Kürkçü, Eroğlu, & Yüksek, 2007). In this branch where physical and motor features are very prominent, it is important to know how these characteristics affect each other, and to control choice of skills and exercise planning (Bulğay, & Çetin, 2018). Wrestling can be defined as a fight of two wrestlers to gain superiority through technique, skills, strength and intelligence in accordance with the rules of the International Wrestling Federation (FILA) (Aslan, Karakollukçu, Güll, & Fişne, 2013). In wrestling, games require very fast movements in a short time, matches consist of 2 periods with 3 minutes (Demirkhan, Kutlu, Koz, Özal, & Favre, 2014). Wrestling is one of the most challenging sport that requires anaerobic power due to the high stress on metabolic systems, where the anaerobic energy supplies the short, quick, and explosive all-out burst of maximal power and strength (Lansky, 1999; Cengiz & Demirhan, 2013; Jafari et al., 2016; Nikooie, Cheraghi, & Mohamadipour, 2017). The wrestler athletes can achieve success, when various features are integrated such as; the high strength of the body, physical fitness, mental ability, flexibility, high speed and reaction timethat athlete can make quick defensive or attack (Özer, Şahin, Karakulak, & Aslan, 2017; Cicioğlu et al., 2007; Pryimakov, 2015; Jafari et al., 2016).

Considering of the basic studies in the field of wrestling in the world, Zaccagni (2012) studied on anthropometric characters and body composition of Italian national wrestlers aged of 18 to 33 years. As a conclusion, females competed at above the predicted class for their minimum weight while males were competed at a weight class below the minimum predicted weight. Mirzaei, Curby, Rahmani-Nia, & Moghadasi (2009) samples were consist from physical features of elite Iranian junior freestyle wrestlers and cadet wrestlers. In conclusion, Iranian junior wrestlers' physical characters were similar with elite wrestlers from other countries. Ohya et al. (2015) researched on physical fitness profile of Japanese elit male wrestlers, compared to weight classes. According to Ohya et al. (2015), motor characters were correlated with physical characters and affect each other. On wrestling, there were effect both anaerobic and aerobic powers. Ramirez-Velez et al. (2014) studied on anthropometric characteristics and physical performance of Colombian elite male wrestlers, aged of  $27.9 \pm 6.7$  years. As a conclusion, it was provided an information for tactical and training about Colombian elite male wrestlers. Sterkowicz-Przybycień, Sterkowicz, & Żarów (2011) researched on somatotype and body composition of Polish wrestlers, compared to weight category. In conclusion, physical structe and body composition of wrestlers change by the weight categories and the heavier wrestlers' characteristic type was endomorph-mesomorph, while lighter wrestlers' type was balanced mesomorph. Considering the studies in Turkey, Vardar, Tezel, Öztürk, & Kaya (2007) samples were consist from body composition and anaerobic performance of elite young wrestlers aged between 15 to 19 years. According to Vardar et al. (2007), there was no relation between anaerobic variables and fat mass (%). Demirkhan, Koz, Kutlu, & Favre, (2015) studied on physical and physiological profiles in elite and amateur young wrestlers aged between 15 to 17 years. The results of this study show that for the wrestlers to be in the elite category, there must be training experience, aerobic endurance, and anaerobic power. Aslan et al. (2013) researched on physical and motor characters of young wrestlers aged of 13-15 years. In conclusion, the anaerobic power and aerobic endurance values of wrestlers were found to positively change with the effect of training within a year.

Throughout the history, Turks have given special importance to the wrestling sport and Sivas province located at the eastern part of the Central Anatolia has an important place providing

many Olympic and World champions. Various studies have focused on the just physical characters of the wrestlers; however, the present study focuses on both physical and motor characteristics of the wrestlers. We evaluated the young freestyle wrestlers ages 10 and 21 years with the following aims: (1) to describe the anthropometric and motor characters of wrestlers, and (2) to assessment of the relationships between physical and motor features of young wrestlers from Sivas, Turkey.

## Methods

### Subjects

This work was carried out in January-February 2018 period in Sivas. In the present study, 86 male free-style wrestlers between the ages 10 and 21 years from Sivas province, representing rural environments was attended. Study was carried out under the permission of local boards of Directorate of Youth and Sports of Sivas Province family consent was taken from each individual under 18 years of age, over 18 years of aged individuals' personal consent was taken. Sample were analysed by age groups; 10-14 (schoolboys), 15-17 (cadets) and 18-21 (juniors) years due to the proficiency levels of United World Wrestling (UWW) sport categories. Each group were training 4 days per week and average 12 hours with wrestling trainer.

### Ethics approval and consent to participate

The Sivas survey was conducted with the permission of the Directorate of Youth and Sports of Sivas Province and local sport clubs. Ethical approval was taken from Sivas Cumhuriyet University Ethical Commission (60263016-050.06-12/10/2017), and consent was taken from each child' parents before participating.

### Measurements

According to the standard anthropometric protocols (Lohman, 1988; Weiner & Lourie, 1969), height (cm), weight (kg), biepicondylar humerus (cm) and femur breadths (mm), triceps, subscapular, supraspinale and medial calf skinfolds (mm), flexed and tensed arm girth and calf girth (cm) were measured. Height (H) to the nearest mm with Martin type anthropometer, weight (W) to the nearest 100g by Tanita (SC-330s), breadth was measured to the nearest mm by digital caliper, skinfolds were measured to the nearest mm with Holtain type skinfold, and circumferences were measured by non-elastic tape.

Body Composition Analyses, such as, Fat Percentage (F%), Fat Mass (FM), Fat Free Mass (FFM), Muscle Mass (MM) and Body Mass Index ( $\text{kg}/\text{m}^2$ ) (BMI) were conducted using Body Composition Analyzer (Tanita SC-330).

Motor properties, upper extremity strength, speed, flexibility and durability characteristics have been determined. Plate tapping test - speed of the limb movement, standing broad jump test - measures explosive leg power, handgrip test with dynamometer (Takei-Japan) - measures static arm strength, sit-ups in 30 seconds - measures trunk strength, and standing medicine ball test - measures arm strength were applied (Pescatelo, 2000).

### Statistics

The data were analysed using Statistical Package for Social Science (SPSS) version 23. Kolmogorov-Smirnov test was used to find out whether the data had a normal distribution and looked at the skewness and kurtosis and it was found that the data have a normal distribution. The descriptive statistics (mean and standard deviation) was conducted, student t-test (independent sample test) was used to understand the relationship between variables, and Pearson correlation analysis and multiple linear regressions were applied.

## Results

Descriptive statistics and independent sample t-test results, Pearson correlation analysis and multiple linear regression results are given in Tables (1-9).

It has been seen that the data (the physical characteristics of young wrestlers) are placed within the normal distribution boundaries, when looked at based on the central and dispersion parameters the values of the skewness and the kurtosis. Physical

characteristics of young wrestlers by age groups (schoolboys-cadet) showed that there is a significant difference between weight, height, upper arm length, supriliac, supraspinale, supscapular, biceps, triceps and calf skinfolds, bust height, upper leg length, biceps girth (tensed and flexed), calf girth, fat percentage and mass, free fat mass, muscle mass and body mass index values ( $p < 0.05$ ). Furthermore, there is a significant difference all of values between the cadets and juniors in Table 1.

**Table 1.** Descriptive statistics on physical features by age group

	Schoolboys (n=41)		Cadets (n=21)		Juniors (n=24)		Skewness	Kurtosis
	Mean	SD	Mean	SD	Mean	SD		
Weight (kg)	51.12	18.26	72.2**	15.43	80.00**	11.88	-.066	.628
Height (cm)	154.50	13.03	168.04**	4.41	170.45**	6.74	-.893	.458
Upper Arm Length (cm)	374.96	45.03	407.81**	24.78	421.30**	23.43	-.841	.819
Supriliac Skinfold (mm)	5.71	4.80	6.48**	4.68	5.56**	4.72	-.178	-.963
Supraspinale Skinfold (mm)	8.91	3.27	10.24**	0.21	9.89**	1.71	-.573	.874
Supscapular Skinfold (mm)	9.57	2.38	10.23**	0.15	10.27**	0.19	-.870	.073
Bust Height (cm)	838.91	71.65	900.57**	27.29	896.13**	39.45	-.934	.302
Upper Leg Length (cm)	500.63	53.70	572.07**	49.75	539.43**	33.85	-.161	.309
Biceps Girth (Tensed) (cm)	25.29	4.25	28.52**	3.82	31.58**	3.65	-.087	-.125
Biceps Girth (Flexed)	29.42	5.12	34.43**	4.34	35.44**	3.69	-.263	-.342
Biceps Skinfold (mm)	2.11	3.45	1.02**	2.14	0.66**	0.46	.170	.189
Triceps Skinfold (mm)	8.01	4.00	9.27**	2.77	8.73**	3.44	-1.748	1.074
Calf Skinfold (mm)	7.24	4.40	6.20**	4.64	2.07**	3.28	.133	-1.979
Calf Girth (cm)	32.29	4.41	35.27**	3.96	36.29**	2.89	-.142	-.018
Fat %	17.26	5.95	16.51**	6.61	15.90**	5.50	-.007	.100
Fat Mass	10.51	6.64	14.40**	6.79	13.01**	5.74	1.073	.692
Free Fat Mass	46.11	12.75	61.17**	9.28	66.92**	8.30	-.387	-.561
Muscle Mass	43.70	12.15	58.05**	8.80	63.36**	7.97	-.378	-.554
Body Mass Index	20.93	3.84	25.61**	5.29	27.51**	2.32	.239	-.295

Note: \* $<0.05$ ; \*\*  $p<0.001$  difference between successive age groups using student t-test

It has been seen that the data (the motor features of young wrestlers) are placed within the normal distribution boundaries, when looked at based on the central and dispersion parameters the values of the skewness and the kurtosis. The results showed a significant difference in plate tapping test, standing

broad jump test, handgrip test (right and left), sit-ups in thirty seconds and standing medicine ball values in motor features between the schoolboys and cadets (Table 2). Also, in motor tests between the cadets and juniors, there is a significant difference all of values.

**Table 2.** Descriptive statistics on motor features by age groups

	Schoolboys (n=41)		Cadets (n=21)		Juniors (n=24)		Skewness	Kurtosis
	Mean	SD	Mean	SD	Mean	SD		
Plate Tapping Test	13.40	2.99	11.06**	1.69	10.82**	1.30	1.851	.575
Standing Broad Jump Test (cm)	194.99	20.29	226.17**	16.93	242.69**	19.83	-.159	-.801
Right Handgrip Test	28.41	10.89	45.10**	8.16	46.73**	3.15	-.457	-.598
Left Handgrip Test	27.04	11.33	41.43**	8.65	45.47**	4.66	-.478	-.697
Sit-ups in thirty seconds	26.08	5.88	32.31**	5.76	37.29**	3.99	-.231	-.477
Standing Medicine Ball Test (m)	5.22	1.81	7.81**	1.96	9.52**	1.16	-.200	-1.029

Note: \* $<0.05$ ; \*\*  $p<0.001$  difference between successive age groups using student t-test

According to the results of correlation analysis, significant relationships weight, height, upper arm length, supriliac, supraspinale, supscapular, biceps, triceps and calf skinfolds, bust

height, upper leg length, biceps girth (tensed-flexed) and calf girth with plate tapping test, standing broad jump test, handgrip test (right-left), sit-ups in thirty seconds test and stand-

ing medicine ball test were observed. Similarly, F%, FM, FFM, MM and BMI values with these performance values are significantly correlated. However, there are high correlation co-

efficients between weight, height, biceps girth, FFM, MM and BMI, and handgrip test and standing medicine ball test (Table 3) measures.

**Table 3.** Relationship coefficients between physical and motor features (pearson correlation analysis)

<b>Correlations</b>		<b>PTT</b>	<b>SBJT</b>	<b>RHT</b>	<b>LHT</b>	<b>STST</b>	<b>SMBT</b>
Weight	r	-.560**	.447**	.764**	.757**	.573**	.809**
	p	.000	.000	.000	.000	.000	.000
Height	r	-.578**	.468**	.727**	.738**	.572**	.703**
	p	.000	.000	.000	.000	.000	.000
Upper Arm Length	r	-.349**	.320**	.500**	.509**	.433**	.580**
	p	.000	.000	.000	.000	.000	.000
Suprailiac Sf.	r	-.154**	-.201**	.120**	.130**	.037**	.177**
	p	.000	.000	.000	.000	.005	.000
Supraspinale Sf.	r	-.214**	.107**	.208**	.250**	.212**	.265**
	p	.000	.000	.000	.000	.000	.000
Subscapular Sf.	r	-.297**	-.025	.159**	.202**	.105**	.220**
	p	.000	.000	.000	.000	.000	.000
Bust Height	r	-.573**	.441**	.679**	.693**	.525**	.641**
	p	.000	.000	.000	.000	.000	.000
Upper Leg Length	r	-.518**	.357**	.622**	.591**	.435**	.580**
	p	.000	.000	.000	.000	.000	.000
Biceps Girth (T)	r	-.579**	.500**	.690**	.759**	.507**	.693**
	p	.000	.000	.000	.000	.000	.000
Biceps Girth (F)	r	-.618**	.466**	.693**	.752**	.528**	.672**
	p	.000	.000	.000	.000	.000	.000
Biceps Sf.	r	.139**	-.333**	-.318**	-.317**	-.185**	-.343**
	p	.000	.000	.000	.000	.000	.000
Triceps Sf.	r	-.203**	.047**	.229**	.202**	.076**	.114**
	p	.000	.000	.000	.000	.000	.000
Calf Sf.	r	.141**	-.465**	-.293**	-.286**	-.473**	-.384**
	p	.000	.000	.000	.000	.000	.000
Calf Girth	r	-.473**	.310**	.606**	.595**	.421**	.589**
	p	.000	.000	.000	.000	.000	.000
Fat %	r	.026*	-.310**	-.064**	.014	-.101**	.041**
	p	.049	.000	.000	.302	.000	.002
Fat Mass	r	-.307**	.032*	.438**	.447**	.235**	.463**
	p	.000	.017	.000	.000	.000	.000
Free Fat Mass	r	-.597**	.560**	.815**	.806**	.641**	.833**
	p	.000	.000	.000	.000	.000	.000
Muscle Mass	r	-.595**	.559**	.814**	.805**	.638**	.830**
	p	.000	.000	.000	.000	.000	.000
Body Mass Index	r	-.521**	.358**	.678**	.669**	.494**	.734**
	p	.000	.000	.000	.000	.000	.000

Note: PTT - Plate tapping test; SBJT - Standing broad jump test; RHT - Right handgrip test; LHT - Left handgrip test; STST - Sit-ups in thirty second test; SMBT - Standing medicine ball test, Sf - Skinfold; \*\*- Correlation is significant at the 0.01 level (2-tailed); \* - Correlation is significant at the 0.05 level (2-tailed).

Regression analysis results are given in Table 4, the selected physical properties give a statistically significant relationship with the plate tapping test in the schoolboys, cadets and juniors. The plate tapping test explains 64% of the total variance on the schoolboys, while this rate is 87% in the cadets and 84% in juniors. According to standard-

ized regression coefficient ( $\beta$ ), the importance of variables on plate tapping test for the schoolboys is MM, FFM and BMI, respectively. While these values on the cadets are BMI, MM and FM, and FM, F% and tensed arm girth on juniors, respectively. Weight and height are not included because of high correlation, these are excluded variables.

**Table 4.** Regression analysis of the plate tapping test by age group

Age Group	Schoolboys (n=41)			Cadets (n=21)			Juniors (n=24)		
	R=.802 R2=.643	F=197.14 p=.000		R=.937 R2=.878	F=634.57 p=.000		R=.920 R2=.846	F=548.83 p=.000	
	Beta	t	p	Beta	t	p	Beta	t	p
Weight	-.425	-2.673	.008				-1.634	-28.005	.000
Height	-1.631	-15.123	.000	2.14	11.554	.000	.641	7.273	.000
Upper Arm Length	-.025	-1.430	.153	-.080	-3.482	.001	-.664	-14.687	.000
Suprailiac Sf.	.036	1.274	.203	.126	6.359	.000	1.200	53.133	.000
Supraspinale Sf.	-.020	-1.000	.317	.434	21.648	.000	-.243	-16.143	.000
Subscapular Sf.	-.069	-3.744	.000	-.150	-3.984	.000	.995	34.208	.000
Bust Height	-.246	-5.902	.000	.507	22.047	.000	-1.027	-27.139	.000
Upper Leg Length	-.064	-1.760	.079	-.030	-.603	.547	-1.678	-31.991	.000
Tensed Arm Girth	.420	7.579	.000	.087	1.019	.309	-3.919	-53.494	.000
Flexed Arm Girth	-.260	-4.772	.000	.480	8.893	.000	3.023	43.325	.000
Biceps Sf.	-.006	-2.277	.782	.172	4.340	.000	.272	17.836	.000
Triceps Sf.	-.007	-3.63	.717	-.064	-2.901	.004	.724	32.396	.000
Calf Sf.	-.223	-11.638	.000	.473	15.998	.000	1.283	41.395	.000
Calf Girth	.181	5.678	.000	.491	15.277	.000	-.196	-7.178	.000
Fat Percentage	.765	14.477	.000	.269	19.581	.000	-6.404	-25.618	.000
Fat Mass	.545	6.581	.000	-4.711	-13.869	.000	7.389	26.054	.000
Free Fat Mass	-5.194	-7.725	.000				-2.732	-7.275	.000
Muscle Mass	7.499	12.083	.000	-5.94	-12.828	.000	2.114	5.642	.000
Body Mass Index	-1.898	-16.151	.000	7.73	10.05	.000	-.405	-4.761	.000

Note: R – multiple regression coefficient, R2 – dependent variable measuring power, F – value of F-test, p – significance level, Beta – value of beta coefficient, t – value of t-test

The selected physical properties give a statistically significant relationship with the standing broad jump test in the schoolboys, cadets and juniors. The standing broad jump test explains 78% of

the total variance on the schoolboys, while this rate is 88% in the cadets and 92% in juniors (Table 5).

**Table 5.** Regression analysis of the standing broad jump test by age group

Age Group	Schoolboys (n=41)			Cadets (n=21)			Juniors (n=24)		
	R=.888 R2=.789	F=408.99 p=.000		R=.941 R2=.885	F=683.13 p=.000		R=.963 R2=.927	F=1275.26 p=.000	
	Beta	t	p	Beta	t	p	Beta	t	p
Weight	-.024	-.197	.844				.485	12.103	.000
Height	-1.132	-13.647	.000	-1.705	-9.509	.000	-.263	-4.345	.000
Upper Arm Length	-.164	-12.098	.000	-.539	-24.177	.000	-.209	-6.733	.000
Suprailiac Sf.	.135	6.258	.000	-.816	-42.445	.000	-.900	-57.992	.000
Supraspinale Sf.	.016	1.012	.311	.169	8.678	.000	.186	18.031	.000
Subscapular Sf.	-.018	-1.235	.217	-.429	-11.784	.000	-.422	-21.141	.000
Bust Height	.303	9.455	.000	-.690	-30.998	.000	.642	24.682	.000
Upper Leg Length	.119	4.241	.000	.472	9.936	.000	.891	24.721	.000
Tensed Arm Girth	-.342	-8.028	.000	.902	10.861	.000	1.170	23.253	.000
Flexed Arm Girth	-.650	-15.482	.000	-.246	-4.714	.000	-1.156	-24.108	.000

(continued on next page)

(continued from previous page)

Age Group	Schoolboys (n=41)			Cadets (n=21)			Juniors (n=24)		
	R=.888 R2=.789	F=408.99 p=.000	R=.941 R2=.885	F=683.13 p=.000	R=.963 R2=.927	F=1275.26 p=.000			
	Beta	t	p	Beta	t	p	Beta	t	p
Biceps Sf.	-.156	-9.008	.000	-.058	-1.508	.132	.089	8.490	.000
Triceps Sf.	.154	10.468	.000	-.126	-5.924	.000	.185	12.04	.000
Calf Sf.	-.313	-21.304	.000	.035	1.217	.224	-.353	-16.573	.000
Calf Girth	.285	11.664	.000	-.926	-29.749	.000	-.699	-37.179	.000
Fat Percentage	-.213	-5.238	.000	-.079	-5.928	.000	10.3	59.984	.000
Fat Mass	.275	4.323	.000	4.733	14.395	.000	-9.875	-50.692	.000
Free Fat Mass	9.181	17.759	.000				-.193	-.749	.454
Muscle Mass	-6.409	-13.430	.000	6.553	14.619	.000	3.508	13.631	.000
Body Mass Index	-1.385	-15.327	.000	-8.852	-11.889	.000	-1.024	-17.548	.000

Note: R – multiple regression coefficient, R2 – dependent variable measuring power, F – value of F-test, p – significance level, Beta – value of beta coefficient, t – value of t-test

According to Table 6; the selected anthropological measurements give a statistically significant relationship with the right handgrip test in the schoolboys, cadets and juniors. The right handgrip test explains 87% of the total variance on the schoolboys, while this rate is 97% in the cadets and 92% in ju-

niors. According to standardized regression coefficient ( $\beta$ ), the importance of variables on right handgrip test for the schoolboys are MM, FFM and weight, respectively. While these values on the cadets are BMI, MM and FM; and F%, FM and FFM on the juniors.

**Table 6.** Regression analysis of the right handgrip test by age group

Age Group	Schoolboys (n=41)			Cadets (n=21)			Juniors (n=24)		
	R=.938 R2=.879	F=793.44 p=.000	R=.985 R2=.970	F=2893.76 p=.000	R=.959 R2=.920	F=1144.27 p=.000			
	Beta	t	p	Beta	t	p	Beta	t	p
Weight	1.311	14.159	.000				-.1466	-34.785	.000
Height	.618	9.834	.000	-.1056	-11.581	.000	2.571	40.407	.000
Upper Arm Length	.001	.074	.941	-.024	-2.131	.033	-.172	-5.266	.000
Suprailiac Sf.	-.216	-13.194	.000	-.358	-36.590	.000	.295	18.088	.000
Supraspinale Sf.	.033	2.793	.005	-.129	-13.027	.000	-.418	-38.497	.000
Subscapular Sf.	-.242	-22.498	.000	-.367	-19.833	.000	.515	24.532	.000
Bust Height	.073	3.002	.003	-.187	-16.523	.000	-1.147	-41.973	.000
Upper Leg Length	.124	5.877	.000	-.577	-23.874	.000	-1.343	-35.45	.000
Tensed Arm Girth	-.084	-2.596	.010	2.030	48.039	.000	-1.354	-25.589	.000
Flexed Arm Girth	-.203	-6.386	.000	-.276	-10.402	.000	1.294	25.683	.000
Biceps Sf.	-.287	-21.824	.000	1.152	59.059	.000	.709	64.321	.000
Triceps Sf.	.179	16.029	.000	.030	2.732	.006	-.040	-2.467	.014
Calf Sf.	-.220	-19.732	.000	.107	7.323	.000	.471	21.037	.000
Calf Girth	-.220	-11.845	.000	-.406	-25.616	.000	.098	4.948	.000
Fat Percentage	.066	2.133	.033	-.704	-104.11	.000	-4.414	-24.45	.000
Fat Mass	-.162	-3.359	.001	3.068	18.343	.000	3.617	17.659	.000
Free Fat Mass	1.569	4.005	.000				-.3244	-11.96	.000
Muscle Mass	-2.413	-6.673	.000	3.915	17.173	.000	2.423	8.955	.000
Body Mass Index	.329	4.799	.000	-.571	-14.711	.000	.785	12.789	.000

Note: R – multiple regression coefficient, R2 – dependent variable measuring power, F – value of F-test, p – significance level, Beta – value of beta coefficient, t – value of t-test

The selected anthropological measurements were significant for the left handgrip test in the schoolboys, cadets and juniors. The left handgrip test explains 92% of the total variance on schoolboys, while this rate is 94% in the cadets and 87% in juniors. According to

standardized regression coefficient ( $\beta$ ), the importance of variables on left handgrip test for schoolboys is FFM, MM and flexed arm girth, respectively. While these values on the cadets are BMI, FM and MM; and F%, FM and FFM on the juniors (Table 7).

**Table 7.** Regression analysis of the left handgrip test by age group

Age Group	Schoolboys (n=41)			Cadets (n=21)			Juniors (n=24)		
	R=.964 R2=.929	F=1420.04 p=.000	R=.972 R2=.945	F=1511.24 p=.000	R=.935 R2=.874	F=695.02 p=.000			
	Beta	t	p	Beta	t	p	Beta	t	p
Weight	-.057	-.799	.424				-,964	-18.288	.000
Height	.105	2.178	.030	-1.185	-9.516	.000	.546	6.860	.000
Upper Arm Length	.054	6.838	.000	-,054	-3.513	.000	-,886	-21.693	.000
Suprailiac Sf.	-,066	-5.222	.000	-,239	-17.86	.000	-,091	-4.477	.000
Supraspinale Sf.	-,002	-,229	,819	-,136	-10.058	.000	-,047	-3.470	,001
Subscapular Sf.	-,132	-15.933	.000	-,582	-23.033	.000	,713	27.151	.000
Bust Height	-,217	-11.636	.000	,124	8.045	.000	,501	14.669	.000
Upper Leg Length	-,207	-12.712	.000	-,595	-18.028	.000	,189	3.982	.000
Tensed Arm Girth	,412	16.587	.000	1.333	23.108	.000	-,342	-5.168	.000
Flexed Arm Girth	-,614	-25.128	.000	,168	4.618	.000	,371	5.892	.000
Biceps Sf.	-,130	-12.883	.000	,854	32.042	.000	,138	10.041	.000
Triceps Sf.	,168	19.552	.000	-,199	-13.46	.000	,211	10.441	.000
Calf Sf.	-,144	-16.854	.000	-,453	-22.755	.000	-,016	-,575	,566
Calf Girth	-,203	-14.26	.000	-,496	-22.953	.000	-,480	-19.44	.000
Fat Percentage	,161	6.810	.000	-,528	-57.182	.000	,6.22	27.542	.000
Fat Mass	,055	1.489	,137	5.094	22.307	.000	-,5.441	-21.236	.000
Free Fat Mass	3.729	12.390	.000				3.151	9.287	.000
Muscle Mass	-,1.887	-6.792	.000	3.935	12.640	.000	-,875	-2.584	,010
Body Mass Index	-,445	-8.457	.000	-,7.183	-13.892	.000	-,595	-7.755	.000

Note: R – multiple regression coefficient, R2 – dependent variable measuring power, F – value of F-test, p – significance level, Beta – value of beta coefficient, t – value of t-test

According to the regression analysis results (Table 8) the selected physical properties showed significant relationship with the sit-ups in thirty seconds test in the schoolboys, cadets and juniors.

The sit-ups in thirty seconds test explain 70% of the total variance on schoolboys, while this rate is 82% in the cadets and 95% in juniors.

**Table 8.** Regression analysis of the sit-ups in thirty seconds test by age group

Age Group	Schoolboys (n=41)			Cadets (n=21)			Juniors (n=24)		
	R=.840 R2=.706	F=262.88 p=.000	R=.909 R2=.825	F=417.84 p=.000	R=.979 R2=.958	F=2276.40 p=.000			
	Beta	t	p	Beta	t	p	Beta	t	p
Weight	,584	4.046	.000				-,215	-7.064	.000
Height	-,974	-9.953	.000	-4.640	-20.959	.000	,214	4.658	.000
Upper Arm Length	-,017	-1.086	,278	-,432	-15.710	.000	,666	28.204	.000
Suprailiac Sf.	-,153	-5.987	.000	-,063	-2.669	,008	-,247	-20.897	.000
Supraspinale Sf.	,075	4.140	.000	-,096	-4.016	.000	,652	82.842	.000
Subscapular Sf.	-,125	-7.460	.000	-,1.695	-37.723	.000	-,1.671	-109.923	.000
Bust Height	,606	16.058	.000	-,527	-19.179	.000	,246	12.435	.000
Upper Leg Length	,514	15.581	.000	,425	7.245	.000	3.102	113.185	.000
Tensed Arm Girth	-,220	-4.362	.000	2.625	25.591	.000	2.287	59.745	.000
Flexed Arm Girth	,230	4.636	.000	-,1.284	-19.901	.000	-,1.547	-42.417	.000
Biceps Sf.	,140	6.832	.000	1.584	33.449	.000	-,500	-62.655	.000
Triceps Sf.	-,123	-7.074	.000	-,875	-33.238	.000	,115	9.808	.000
Calf Sf.	-,390	-22.457	.000	-,566	-15.995	.000	-,1.46	-90.185	.000
Calf Girth	,133	4.595	.000	-,187	-4.862	.000	-,294	-20.580	.000

(continued on next page)

(continued from previous page)

Age Group	Schoolboys (n=41)			Cadets (n=21)			Juniors (n=24)		
	R=.840 R2=.706	F=262.88 p=.000	R=.909 R2=.825	F=417.84 p=.000	R=.979 R2=.958	F=2276.40 p=.000			
	Beta	t	p	Beta	t	p	Beta	t	p
Fat Percentage	.110	2.289	.022	-.254	-15.460	.000	3.614	27.665	.000
Fat Mass	-.182	-2.423	.015	11.716	28.864	.000	-3.556	-23.995	.000
Free Fat Mass	5.011	8.213	.000				6.173	31.453	.000
Muscle Mass	-4.488	-7.969	.000	12.721	22.988	.000	-6.691	-34.177	.000
Body Mass Index	-.393	-3.688	.000	-21.290	-23.163	.000	.237	5.335	.000

Note: R – multiple regression coefficient, R2 – dependent variable measuring power, F – value of F-test, p – significance level, Beta – value of beta coefficient, t – value of t-test

The selected anthropological measurements showed significant relationship with the standing medicine ball test in the schoolboys, cadets and juniors. The standing medicine ball test explains 87% of the total variance on schoolboys, while this rate is 97% in cadets and 97%

in juniors. According to standardized regression coefficient ( $\beta$ ), the importance of variables on standing medicine ball test for schoolboys is FFM, MM and weight, respectively. While these values on the cadets are BMI, MM, FM and FFM on the juniors, respectively (Table 9).

**Table 9.** Regression analysis of the standing medicine ball test by age group

Age Group	Schoolboys (n=41)			Cadets (n=21)			Juniors (n=24)		
	R=.937 R2=.878	F=787.83 p=.000	R=.989 R2=.979	F=4090.72 p=.000	R=.986 R2=.973	F=3626.69 p=.000			
	Beta	t	p	Beta	t	p	Beta	T	p
Weight	.868	9.344	.000				1.98	81.341	.000
Height	.691	10.956	.000	3.057	39.68	.000	.163	4.425	.000
Upper Arm Length	.032	3.095	.002	-.523	-54.61	.000	-.253	-13.418	.000
Suprailiac Sf.	-.140	-8.536	.000	-.383	-46.356	.000	-.907	-96.188	.000
Supraspinale Sf.	.113	9.711	.000	-.114	-13.657	.000	.380	60.464	.000
Subscapular Sf.	-.099	-9.200	.000	-.085	-5.440	.000	-.875	-72.109	.000
Bust Height	-.298	-12.231	.000	-.490	-51.185	.000	.081	5.126	.000
Upper Leg Length	-.031	-1.455	.146	-.027	-1.325	.185	1.542	70.450	.000
Tensed Arm Girth	-.140	-4.325	.000	-.279	-7.824	.000	2.063	67.502	.000
Flexed Arm Girth	-.306	-9.589	.000	.298	13.265	.000	-.745	-25.582	.000
Biceps Sf.	-.184	-13.961	.000	-.425	-25.768	.000	-.241	-37.861	.000
Triceps Sf.	-.007	-.662	.508	-.053	-5.773	.000	.075	8.045	.000
Calf Sf.	-.165	-14.718	.000	-.182	-14.789	.000	-.1787	-138.241	.000
Calf Girth	.043	2.333	.020	-.491	-36.680	.000	-.574	-50.315	.000
Fat Percentage	-.059	-1.923	.055	-.096	-16.860	.000	-.1502	-14.403	.000
Fat Mass	-.336	-6.936	.000	-3.272	-23.161	.000	1.936	16.363	.000
Free Fat Mass	1.787	4.547	.000				3.354	21.399	.000
Muscle Mass	-1.745	-4.811	.000	-6.508	-33.789	.000	-3.547	-22.692	.000
Body Mass Index	.377	5.494	.000	10.952	34.235	.000	-.728	-20.530	.000

Note: R – multiple regression coefficient, R2 – dependent variable measuring power, F – value of F-test, p – significance level, Beta – value of beta coefficient, t – value of t-test

## Discussion

By evaluating the data obtained from the present study, it was found that the selected physical properties were significantly correlated with all of the motor features and affected them significantly. Özer et al. (2017) studied on young amateur wrestlers -the athletes who regularly train for a year (13 to 14 years). In the present study, height and weight values are 158.2 cm and 56.3 kg, while Özer et al. (2017) found that 162.9 cm and 57.4 kg., respectively. F%, FM, FFM and BMI values were lower than our result. Their results were 12.01%, 7.70, 49.95 and 21.21 respectively. Fur-

thermore, motor features of the cadet wrestlers (standing broad jump, handgrip test and standing medicine ball throw test) are higher than Özer et al. study. Aslan et al. (2013) found a different result with the present study by physical and motor features. Their work area was amateur wrestlers who regularly train in Sivas between the ages of 13 and 15. Their height and weight values were similar with our result, 160.4 cm and 53.7kg, respectively. The present study' motor features (standing broad jump, handgrip test, sit-ups in 30 seconds and standing medicine ball throw) are higher than Aslan et al. (2013) study. According to Taşkiran

(2014), comparing with our result, some anthropometric characters of U.S. National Freestyle Wrestling Team (24 ages) were higher than our result (height and weight values). Then, their body fat value (9.45%) were lower than our wrestlers' body fat value (juniors). However, their handgrip test score (50.38) is higher than our result. Similarly, Zaccagni' (2012) samples (Italian National wrestlers aged of 18 to 33 years) show that F%, FM and FFM values were lower than our result: their results were 10.1, 7.7 and 65.5, respectively. Vardar et al. (2007) samples (Turkish cadet and juniors national team wrestlers) show that their body fat percentage and mass values were lower than our result (9.7% and 7.9). These results (including our results) demonstrated to percent body fat above the minimum recommended by the ACSM (5% for males). According to Yoon (2002), the body fat (%) should be ranges from 3-13 in well-trained wrestlers.

The correlation analysis results demonstrate that there were positive or negative correlation coefficients between many of the physical properties and motor properties. According to Pearson correlation analysis, the all of motor features are increase except plate tapping, when the physical characters rised together with age. There is a high correlation coefficient between weight, height, biceps girth, fat free mass, muscle mass and body mass index, and handgrip test and standing medicine ball test which are indicators of upper extremity explosive force. According to Özer et al. (2017), handgrip forces and standing medicine ball power are rising, when body mass increased. Cvetković, Marić, & Marelić (2005) studied 16 to 20 years old young wrestlers who are preparing for the European and World Championships in Croatia. They argued that body height and body weight were high and positive correlated with throwing medicine ball.

The wrestling has anaerobic and aerobic energy systems, like many other sports (Karnincic, Tocilj, Uljevic, & Erceg, 2009; Mirzaei, Moghaddam, & Abadi, 2017). While the anaerobic system provides maximum power explosion during the match or training, the aerobic system is effective in the effort and improvement of the athletes during the match. Markovic & Jaric (2007) reported that body weight positively affects force and anaerobic power. These motor features are affected by the physical characters (Ohya et al., 2015; Zaccagni, 2015). However, some researchers, such as Horswill (1992) and Mirzaei et al. (2009) say that only anaerobic power is effective, when studied on Elite Iranian junior freestyle wrestlers. While Ohya et al. (2015) (studied on light, middle, and heavy weight-class groups of Japanese elite male wrestlers) argue that both anaerobic and aerobic powers is effective. Yoon (2002) claims that aerobic capacity is also one of the important factors to be successful in wrestling sport. The present study results showed that body weight, muscle mass and fat free mass affects on anaerobic power, such as standing broad jump test and standing medicine ball test.

Compared to the other sports, Tharp, Johnson, & Thorland (1984) reported that anaerobic power is related to age, body weight and most importantly, lean body mass on athletes. According to Ostojic, Majic, & Dikic (2006) there is a strong correlation between body composition and anaerobic power on basketball players, and Silvestre, West, Maresh, & Kraemer (2006) reported that there were significant correlations between body composition, vertical jump and anaerobic power on football players. The physical characteristics of the all of wrestler groups were determined to have a significant effect on plate tapping test, standing broad jump, hand-grip (right and left), sit-ups in thirty seconds and standing medicine ball characteristics, when the results of multiple linear regression analysis are examined. In the study of Cvetković et al (2005), they found that standing medicine ball test and handgrip (right-left) test were also significantly affect on body height and weight. Ac-

cording to standardized regression coefficient ( $\beta$ ), especially, muscle mass, body mass index and fat free mass values are significantly relationship on physical characters in all age groups. This may be caused by the development of the muscle groups (body density). As a result of this, the high muscular endurance allows a good stability in attack or defense positions (Mirzaei, Curby, Barbas, & Lotfi, 2011). Furthermore, fat free mass and body composition are indicator and predictor of muscle mass and could increase an individual's production of speed, strength and power. This situation is related to sporty performance (Stojanović, Bešić, Stojanović, Lilić, & Zadražnik, 2018). According to Demirkan et al. (2015) handgrip strength (left), flexibility of the low back and hamstring were one of the most important factors to predicting wrestling success.

In conclusion, the present study results showed that wrestlers from all age groups have presented with high level of fat mass, muscle mass and fat free mass where motor and physical properties are highly correlated among the wrestling athletes in accordance with the special training methods. In order to be successful, not only anaerobic power but also aerobic power should be given importance. Also, trainers should help wrestlers in training.

#### Acknowledgements

The authors appreciate all the wrestlers and coaches who cooperated with us.

#### Conflict of Interest

The authors declare that there are no conflicts of interest.

**Received:** 6 June 2019 | **Accepted:** 16 September 2019 | **Published:** 10 January 2020

#### References

- Aslan, C.S., Karakollukçu, M., Güll, M., & Fişne, M. (2013). Comparison of Annual Changes in Selected Physical and Motoric Characteristics in Age 13-15 Wrestlers. *Sports Medicine Journal*, 48, 1-7.
- Bulğay, C. & Çetin, E. (2018). Examination of Physical, Motor and Physiological Characteristics of Athletes and Wrestlers Between the Ages of 12 and 14 in Terms of Branching. *International Journal of Applied Exercise Physiology*, 7(1), 1-10.
- Cengiz, A. & Demirhan, B. (2013). Physiology of Wrestlers' Dehydration. *Turkish Journal of Sport and Exercise*, 15(2), 1-10.
- Chaabene, H., Negra, Y., Bouguezzi, R., Mkaouer, B., Franchini, E., Julio, U., & Hachana, Y. (2017). Physical and Physiological Attributes of Wrestlers. *Journal of Strength and Conditioning Research*, 31(5), 1411-1442. doi: 10.1519/jsc.00000000000001738
- Cicioğlu, H.I., Kürkçü, R., Eroğlu, H., & Yüksek, S. (2007). Seasonal Changes on Some Physical and Physiological Characteristics of Wrestlers Aged 15-17 Years. *Spormetre, Beden Eğitimi ve Spor Bilimleri Dergisi*, 4, 151-156.
- Cvetković, Č., Marić, J., & Marelić, N. (2005). Technical Efficiency of Wrestlers in Relation to Some Anthropometric and Motor Variables. *Kinesiology*, 37(1), 74-83.
- Demirkan, E., Koz, M., Kutlu, M., & Favre, M. (2015). Comparison of Physical and Physiological Profiles in Elite and Amateur Young Wrestlers. *Journal of Strength and Conditioning Research*, 29(7), 1876-1883.
- Demirkan, E., Kutlu, M., Koz, M., Özal, M., & Favre, M. (2014). Physical Fitness Differences between Freestyle and Greco-Roman Junior Wrestlers. *Journal of Human Kinetics*, 41, 245-251.
- Horswill, C.A. (1992). Applied Physiology of Amateur Wrestling. *Sports Medicine*, 14(2), 114-143.
- Jafari, R.A., Damirchi, A., Mirzaei, B., & Nobari, H. (2016). Anthropometrical Profile and Bio-motor Abilities of Young Elite Wrestlers. *Physical Education of Sports*, 6, 63-69.
- Karnincic, H., Tocilj, Z., Uljevic, O., & Erceg, M. (2009). Lactate Profile During Greco-Roman Wrestling Match. *Journal of Sports Science & Medicine*, 8(3), 17-19.
- Lansky, R.C. (1999). Wrestling and Olympic-style Lifts: In Season Maintenance of Power and Anaerobic Endurance. *Strength Conditioning Journal*, 21, 21-27.
- Lohman, T.G., Roche, A.F., & Martorell, R. (1988). *Anthropometric Standardization Reference Manual*. Champaign, IL: Human Kinetics Books.
- Markovic, G., & Jaric, S. (2007). Is Vertical Jump Height a Body Size-Independent Measure of Muscle Power? *Journal of Sports Sciences*, 25, 1355-1363.
- Mirzaei, B., Curby, D. G., Rahmani-Nia, F., & Moghadasi, M. (2009). Physiolog-

- ical Profile of Elite Iranian Junior Freestyle Wrestlers. *Journal of Strength and Conditioning Research*, 23(8), 2339–2344.
- Mirzaei, B., Curby, D.G., Barbas, I., & Lotfi, N. (2011). Physical Fitness Measures of Cadet Wrestlers. *International Journal of Wrestling Science*, 1, 1-4.
- Mirzaei, B., Moghaddam, M.G., & Abadi, H.A.Y. (2017). Analysis of Energy Systems in Greco-Roman and Freestyle Wrestlers Who Participated in the 2015 and 2016 World Championships. *International Journal of Wrestling Science*, 7, 35–40.
- Nikooie, R., Cheraghi, M., & Mohamadipour, F. (2017). Physiological Determinants of Wrestling Success in Elite Iranian Senior and Junior Greco-Roman Wrestlers. *The Journal of Sports Medicine and Physical Fitness*, 57(3), 219–26.
- Ohya, T., Takashima, W., Hagiwara, M., Oriishi, M., Hoshikawa, M., Nishiguchi, S., & Suzuki, Y. (2015). Physical Fitness Profile and Differences Between Light, Middle, and Heavy Weight-Class Groups of Japanese Elite Male Wrestlers. *International Journal of Wrestling Science*, 5(1), 42–46.
- Ostojic, S.M., Majic, S., & Dikic, N. (2006). Profiling in Basketball: Physical and Physiological Characteristics of Elite Players. *The Journal of Strength & Conditioning Research*, 20, 740–744.
- Özer, U., Şahin, A., Karakulak, İ., & Aslan, C.S. (2017). Investigation of the Relationships Between Physical and Motor Features in Young Wrestlers. *Journal of International Multidisciplinary Academic Researches*, 4(3), 13–25.
- Pescatello, L.S. (2000). ACSM's (American College of Sports Medicine) guidelines for exercise testing and prescription. Baltimore: Williams & Wilkins.
- Pryimakov, O., Masenko, L., & Lachno, D. (2015). Associations Between Major Indices of Physical Development and Fitness and The Level of Elite Wrestler Special Work Capacity. *Central European Journal of Sport Sciences and Medicine*, 11(3), 87–94.
- Ramirez-Velez, R., Argothyd, R., Meneses-Echavez, J.F., Sanchez-Puccini, M.B., Lopez-Alban, C.A., & Cohen, D.D. (2014). Anthropometric Characteristics and Physical Performance of Colombian Elite Male Wrestlers. *Asian Journal of Sports Medicine*, 5(4), e23810. doi: 10.5812/asjsm.23810
- Silvestre, R., West, C., Maresh, C.M., & Kraemer, W.J. (2006). Body Composition and Physical Performance in Men's Soccer: A Study of a National Collegiate Athletic Association Division I team. *The Journal of Strength & Conditioning Research*, 20(1), 177–183.
- Sterkowicz-Przybycień, K., Sterkowicz, S., & Żarów, R. (2011). Somatotype, Body Composition and Proportionality in Polish Top Greco-Roman Wrestlers. *Journal of Human Kinetics*, 28, 141–154.
- Stojanović, T., Bešić, Đ., Stojanović, D., Lilić, L., & Zadražnik, M. (2018). The Effects of Short-term Preseason Combined Training on Body Composition in Elite Female Volleyball Players. *Anthropological Notebook*, 24(1), 85–95.
- Taskiran, C. (2014). Comparison of the Physical and Physiological Capacities of Elite Turkish Wrestlers and the Wrestlers of the U.S. National Wrestling Team. *International Journal of Wrestling Science*, 4(2), 11–14.
- Tharp, G.D., Johnson, G.O., & Thorland, W.G. (1984). Measurement of Anaerobic Power and Capacity in Elite Young Track Athletes Using the Wingate Test. *The Journal of Sports Medicine and Physical Fitness*, 24, 100–106.
- Vardar, S.A., Tezel, S., Öztürk, L., & Kaya, O. (2007). The Relationship Between Body Composition and Anaerobic Performance of Elite Young Wrestlers. *Journal of Sports Science and Medicine*, 6(2), 34–38.
- Weiner, J.S., & Lourie, J.A. (1969). *Human Biology. A Guide to Field Methods*. Philadelphia, Pennsylvania: F. A. Davis Company.
- Yoon J. (2002). Physiological Profile of Elite Senior Wrestlers. *Sport Medicine*, 32, 225–233.
- Zaccagni, L. (2012). Anthropometric Characteristics and Body Composition of Italian National Wrestlers. *European Journal of Sport Science*, 12(2), 145–151.

**ORIGINAL SCIENTIFIC PAPER**

# Morphological and Functional Characteristics of Army Recruits and Professional Soldiers of Montenegro Armed Forces

Boris Banjević<sup>1</sup><sup>1</sup>Army of Montenegro, Airforce military of Montenegro, Podgorica, Montenegro**Abstract**

The results of kineziology research in the armed forces of the region and world indicate the existence of differences in morphological and functional space of soldiers compared to ethnographical area, age, military speciality and formation arrangement. The aim of this research is to determine the status and possible differences in morphological and functional characteristics with recruits and professional soldiers of Montenegro Armed Forces. The sample of examinees was made of 50 soldiers being 18-25 years old, divided into two groups: 25 recruits from the Training Center in Danilovgrad and 25 professional soldiers of the Navy and Infantry Battalion of Montenegro Armed Forces. The sample of measures was made of the following morphological and functional indicators: body height, body mass, waist size, hips size, chest size, thigh size, forearm size, abdomen skinfold, chest skinfold, thigh skinfold, body mass index, body fluid percentage, waist-hip ratio, forced volume vital capacity, forced expiratory volume in 1 second, the ratio of forced expiratory volume in 1 second and forced vital capacity and peak expiratory flow. The central and dispersion parameters of variables have been calculated, and for determining the differences in morphological and functional characteristics, the t-test has been applied for small independent samples. Statistically significant differences between the sub-samples of examinees have been determined in the morphological variables of waist size and forearm size, therefore it has been concluded that there's a high coincidence with the majority of morphological and functional parameters. The stated results confirm the need to conduct the research in Montenegro Armed Forces, in order to examine the status and possible existence of morphological and functional differences of soldiers with reference to their age, branch of armed services and military specialty.

**Keywords:** Morphological Characteristics, Functional Characteristics, Differences, Recruits, Soldiers

**Uvod**

Ljudski faktor, sa morfološkim obilježjima, te motoričkim i funkcionalnim sposobnostima, bio je i ostao jedan od najvažnijih ciljeva i kvaliteta u nacionalnim odbranama širom sveta, bez obzira na savremenu borbenu tehnologiju (Marić i sar., 2013). Prilikom selekcije regruta i potencijalnih kadeta, kao i tokom obuke, analiza morfološkog statusa nam govori da je problem sa prekomernom težinom i viškom masnog tkiva prilično aktuelan

(Crawford et al, 2011). Takvo stanje ljudstva u morfološkom smislu, na osnovu istraživanja širom svijeta, direktna je posljedica neadekvatne ishrane i nedovoljne fizičke aktivnosti, što u perspektivi utiče na funkcionalne sposobnosti, a u kasnijim životnim razdobljima ozbiljno ugrožava zdravstveni status pojedinca (Kyrolainen et al., 2008). Ospozobljen i obučen ne može biti nijedan vojnik koji nije u stanju, zahvaljujući svojim antropološkim sposobnostima i karakteristikama obavljati svakodnevne ili van-

Correspondence:

**Montenegro**  
**Sport**

B. Banjević  
 Army of Montenegro, Airforce military of Montenegro, Military airport "Knjaz Danilo" Podgorica, Montenegro  
 E-mail: boris.banjevic@gmail.com

redne zadatke pod povećanim opterećenjem i povećanim zahtjevima na kompletan antropološki status organizma. Spremnost vojnika za izvršavanje višenamjenskih zadataka, treba definisati između ostalog i visokim ili optimalnim stanjem funkcionalnih sposobnosti i poželjnim morfološkim proporcijama tjelesnog sastava (Banjević, 2012).

Morfološke karakteristike opisuju građu tijela vojnika na temelju većeg broja antropometrijskih podataka (Jukić i sar., 2008). Postoje različita mišljenja oko idealne kompozicije tijela za profesionalne vojnike, kako bi se optimizirala fizička pripremljenost neophodna za izvršavanje višenamjenskih vojnih zadataka (Crawford et al., 2011). Pošto testovi fizičke spremnosti nijesu savršen pokazatelj kondicionih potencijala, niti su ti potencijali savršen pokazatelji sposobnosti za obavljanje konkretnе vojne dužnosti, standard nivoa tjelesnih masti na primjer, bio bi dodatni pokazatelj nivoa fizičke aktivnosti i sposobnosti za određeni nivo željenih fizičkih performansi. Štaviše, čak i sa adekvatnim nivoom kondicionih kapaciteta, neprikladno visok nivo tjelesnih masti, može biti faktor rizika za kardiovaskularni sistem i mišićno-koštane povrede. Ovi rizici, barem u vojsci i ostalim bezbjednosnim službama opravdavaju postojanje standarda veličine i sastava tijela, pored standarda fitnessa (Vogel & Friedl, 1992).

Funkcionalna dijagnostika omogućava uvid u pojedine fiziološke i biohemiske karakteristike organizma vojnika. Za procjenu strukturalno funkcionalnih karakteristika respiracijskog sistema, koriste se spirometrijski testovi (Jukić i sar., 2008). Testovi pulmonarne funkcije (PFTs-Pulmonary Function Tests) se obično koriste za procjenu respiratornog statusa i oni su postali dio rutinskog zdravstvenog ispitivanja kod respiratorne, radne i sportske medicin-e (Kaur, Subhedar, Dave, Mishra, & Sharma, 2015). U njegovom istorijskom istraživanju, John Hutchinson (pronalač spirometra) je utvrdio da su godište i visina najvažnije antropometrijske odrednice funkcije pluća, i od tada su mnoga istraživanja potvrdila da se funkcija pluća povećava sa visinom i smanjuje sa godinama starosti (American Thoracic Society). Iako je uticaj tjelesne težine na funkciju pluća vidljiv, dodatno odstupanje je objašnjeno pomoću indeksa tjelesne mase BMI (body mass index). Funkcija pluća se smanjuje na obje krajnosti težine, tj. mršavost ili gojaznost (Dockery et al., 1985). Malo istraživanja je razmatralo veličinu mase tjelesnih masti (FM) i bezmasne mase (FFM) u odnosu na funkciju pluća. Za masu tjelesnih masti je uочeno da se negativno povezuje sa funkcijom pluća, posebno kod veoma gojaznih osoba, dok se pozitivno povezuje za bezmasnu masu (De Lorenzo et al., 2001).

U novije vrijeme se nekoliko studija kod nas i u svijetu bavilo sagledavanjem morfoloških pokazatelja i funkcionalnih karakteristika vojnika (Marrioti & Scott, 1992; Collins, Hoberty, Walker, Fletcher, & Peiris, 1995; Raković-Savčić, 1999; Harik-Khan, Wise, & Fleg, 2001; Babcock, Kirby, McCarroll, & Devor, 2006; Lučić & Aračić, 2008; Jukić i sar., 2008; Marić & Krsmanović, 2010; Banjević, 2012; Abt et al., 2016). Na osnovu navedenih istraživanja, utvrđeno je da se javljaju značajne razlike u morfološkom i funkcionalnom prostoru u odnosu na etnografska područja, kao i specifičnosti formacijske, starosne i specijalističke strukture u vojskama regionala i svijeta. U skladu sa tim, kao i potrebom adekvatne selekcije i provjere određenih morfoloških i funkcionalnih standarda prilikom prijema regruta u Vojsku Crne Gore, postavljen je i cilj ovog istraživanja. On podrazumijeva utvrđivanje stanja i definisanje eventualnih razlika u morfološkim karakteristikama i funkcionalnim sposobnostima regruta i profesionalnih pripadnika Vojske Crne Gore. Ostvarivanjem postavljenog cilja, ukazaće se na eventualno postojanje razlika u morfološkim i funkcionalnim pokazateljima navedenih kategorija u vojsci, donijeće se zaključci bitni sa aspekta uvida u stanje navedenih karakteristika vojnika i dati smjernice za dalja istraživanja po pitanju navedene problematike.

## Metod

U pogledu vremenske određenosti istraživanje je transverzalnog karaktera, a sastoji se u jednokratnom mjerenu odgovarajućih morfoloških i funkcionalnih karakteristika regruta i profesionalnih pripadnika Vojske Crne Gore.

### Uzorak ispitanika

Uzorak ispitanika sačinjavali su regruti i profesionalni pripadnici VCG starosne dobi 18-25 godina. Ukupan broj ispitanika je 50 i podijeljeni su na dva subuzorka. Prvi subuzorak je činilo 25 regruta iz Centra za obuku u Danilovgradu, dok je drugi subuzorak činilo 25 profesionalnih pripadnika iz Pješadijskog bataljona i Mornarice.

### Uzorak mjera

Mjerenje je sprovedeno u posebno pripremljenim prostorijama kasarni u Danilovgradu, Kolašinu i Baru, a ispitanici su bila odjeveni u sportskoj opremi predviđenoj za realizaciju časa fizičke obuke. Uzorak mjera su činili sljedeći morfološki i funkcionalni pokazatelji: visina tijela, masa tijela, obim struka, obim kukova, obim grudnog koša, obim natkoljenice, obim podlaktice, kožni nabor trbuha, kožni nabor grudi, kožni nabor natkoljenice, indeks tjelesne mase, procenat tjelesnih masti, koeficijenat odnosa struka i kukova, forsirani vitalni kapacitet, forsirani ekspiracijski volumen u prvoj sekundi, odnos forsiranog ekspiracijskog volumena u prvoj sekundi i forsiranog vitalnog kapaciteta i vršni izdisajni protok. Za procjenu morfološkog statusa koristili su se sljedeći mjerni instrumenti: antropometar po Martinu, klizni šestar po Martinu, metalna mjerna traka i kaliper tipa John Bull. Parametri tjelesne strukture su izračunati prema sljedećem: indeks tjelesne mase  $BMI = \text{Tjelesna masa (kg)} / \text{Tjelesna visina (m}^2)$ ; procenat tjelesnih masti  $PTM = 4,95 / \text{gustina tijela} - 4,50$ ; koeficijenat odnosa struka i kukova  $KSK = \text{obim struka} / \text{obim kukova}$ . Parametri funkcionalnih sposobnosti su dobijeni putem spirometrije. Antropometrijsko mjerenje je sprovedeno uz poštovanje osnovnih pravila i principa vezanih za izbor mjernih instrumenata i tehnike mjerenja, koji su standardizovani prema uputstvima Internacionalnog biološkog programa (IBP). Parametri tjelesne strukture su izračunati na osnovu Protokola priručnika za procjenu fizičke forme povezane sa zdravljem (Kaminsky, 2013). Spirometrijsko testiranje je realizovano u skladu sa Protokolom dijagnostike funkcionalnih sposobnosti vojnika (Jukić i sar., 2008).

### Metode obrade podataka

Dobijeni rezultati su najprije uređeni, a zatim statistički obrađeni na personalnom računaru pod softverskim statističkim paketom SPSS 20.0. Podaci su obrađeni postupcima deskriptivne i komparativne statističke procedure. Izračunati su centralni i disperzionalni parametri varijabli, a za utvrđivanje razlika u morfološkim i funkcionalnim karakteristikama između regruta i profesionalnih pripadnika Vojske Crne Gore, primjenjen je t-test za male nezavisne uzorce, sa statističkom značajnošću od  $p < 0.05$ .

## Rezultati

U tabelama 1-4 prikazani su osnovni statistički deskriptivni parametri morfoloških i funkcionalnih karakteristika regruta i profesionalnih pripadnika Vojske Crne Gore. Izračunate su sljedeće mjere centralne i disperzione tendencije: aritmetička sredina (Mean), standardna devijacija (S.D.), varijansa (Variance), minimalne (Min) i maksimalne (Max) vrijednosti, koeficijenti nagnutosti (Skewness) i zakrivljenosti (Kurtosis).

Uvidom u rezultate deskriptivne statistike parametara morfoloških varijabli regruta Vojske Crne Gore, prikazanih u Tabeli 1, utvrđena je diskriminativnost mjerjenja analizom standardnih koeficijenata asimetrije. Vrijednost skjunisa za varijable kožni nabor natkoljenice i koeficijenat struka i kukova, ukazuje na negativnu

asimetriju sa dominacijom viših rezultata, dok je kod ostalih varijabli vidljiva pozitivna asimetrija, pa se zaključuje da su rezultati u zonama slabijih vrijednosti sa normalnom ili umjerenom asimetrijom. Negativna vrijednost kurtozisa za varijable obim struka, kožni nabor natkoljenice i koeficijenat struka i kukova, ukazuje na odstupanja u pravcu platikurtične krive (heterogenost rezultata),

odnosno na izraženiju diskriminativnost među ispitanicima, dok njegova pozitivna vrijednost za preostale varijable ukazuje na leptokurtičnost (homogenost rezultata). U mjerama obim grudnog koša (Stat=4.45) i indeks tjelesne mase (Stat=4.64) možemo konstatovati da su regruti Vojske Crne Gore najhomogeniji (izrazita leptokurtičnost).

**Tabela 1.** Centralni i disperzionalni parametri morfoloških varijabli regruta Vojske Crne Gore

Variable	Min	Max	Mean	SD	Variance	Skewness		Kurtosis	
						Stat	SE	Stat	SE
Visina tijela	165.9	199.0	180.9	7.54	56.96	.310	.464	.071	.902
Masa tijela	64.0	129.0	84.0	14.27	203.78	1.44	.464	2.80	.902
Obim struka	72.0	112.0	87.6	10.15	103.17	.575	.464	-.355	.902
Obim kukova	79.0	110.0	90.4	7.45	55.58	.742	.464	.528	.902
Obim grudnog koša	91.5	127.0	100.7	7.87	61.99	1.90	.464	4.45	.902
Obim natkoljenice	51.5	72.0	58.3	4.89	24.00	1.10	.464	1.23	.902
Obim podlaktice	25.0	33.0	28.1	1.77	3.16	.789	.464	1.20	.902
Kožni nabor trbuha	8.0	40.0	17.8	7.62	58.16	1.18	.464	1.61	.902
Kožni nabor grudi	4.0	10.0	5.5	1.50	2.26	1.79	.464	3.02	.902
Kožni nabor natkoljenice	4.0	14.0	8.5	2.51	6.34	-.051	.464	-.401	.902
Indeks tjelesne mase	20.8	37.3	25.6	3.43	11.80	1.74	.464	4.64	.902
Procenat tjelesnih masti	3.8	17.4	8.5	3.02	3.17	1.04	.464	1.61	.902
Koeficijenat struka i kukova	0.8	1.04	0.9	.048	.002	-.669	.464	-.404	.902

Legenda: Min – minimalan rezultat; Max – maksimalan rezultat; Mean – aritmetička sredina; SD – standardna devijacija; Variance – varijansa; Skewness – koeficijent nagnutosti; Kurtosis – koeficijent zakrivljenosti.

Daljom inspekcijom rezultata u Tabeli 2, koji se odnose na funkcionalne pokazatelje regruta Vojske Crne Gore, utvrđeno je sljedeće: vrijednosti skjunisa za varijable forsirani ekspiracijski volumen u 1 sekundi i odnos forsiranog ekspiracijskog volumena u 1 sekundi i forsiranog vitalnog kapaciteta, ukazuju na negativnu

asimetriju sa dominacijom boljih rezultata, dok su za preostale varijable rezultati u zonama slabijih vrijednosti; negativna vrijednost kurtozisa za varijablu forsirani vitalni kapacitet ukazuje na plati-kurtičnost i heterogenost rezultata, dok se u ostalim slučajevima konstatiše leptokurtičnost i homogenost dobijenih vrijednosti.

**Tabela 2.** Centralni i disperzionalni parametri funkcionalnih varijabli regruta Vojske Crne Gore

Variable	Min	Max	Mean	SD	Variance	Skewness		Kurtosis	
						Stat	SE	Stat	SE
FVC	4.2	6.8	5.4	0.70	.497	.435	.464	-.277	.902
FEV1	2.4	5.9	4.5	0.68	.468	-.812	.464	2.94	.902
FEV1/FVC	57.1	97.8	83.3	9.40	88.53	-1.30	.464	1.62	.902
PEF	2.5	12.5	7.9	2.29	5.28	.070	.464	1.26	.902

Legenda: FVC – forsirani vitalni kapacitet; FEV1 – forsirani ekspiracijski volumen u 1 sekundi; FEV1/FVC – odnos forsiranog ekspiracijskog volumena u 1 sekundi i forsiranog vitalnog kapaciteta; PEF – vršni izdisajni protok; Min – minimalan rezultat; Max – maksimalan rezultat; Mean – aritmetička sredina; SD – standardna devijacija; Variance – varijansa; Skewness – koeficijent nagnutosti; Kurtosis – koeficijent zakrivljenosti.

Na osnovu rezultata morfoloških pokazatelja profesionalnih pripadnika Vojske Crne Gore prikazanih u Tabeli 3, uviđa se normalna raspodjela većine varijabli. Prema vrijednostima skjunisa dominantno je zastupljena pozitivna asimetrija sa izraženijim nizim i slabijim rezultatima, osim za varijable visina tijela i obim pod-

lakta, gdje se konstatiše negativna asimetrija sa boljim rezultatima. Koeficijent zakrivljenosti ukazuje na podjednaku zastupljenost heterogenih i homogenih rezultata, tj. na platikurtičnost i leptokurtičnost krive. Inspekcijom navedenih rezultata, utvrđuje se veoma izražena homogenost za varijablu kožni nabor grudi (Stat=6.31).

**Tabela 3.** Centralni i disperzionalni parametri morfoloških varijabli profesionalnih pripadnika Vojske Crne Gore

Variable	Min	Max	Mean	SD	Variance	Skewness		Kurtosis	
						Stat	SE	Stat	SE
Visina tijela	170.5	190.6	182.3	6.31	39.82	-.347	.464	-.998	.902
Masa tijela	64.6	125.8	90.7	13.51	182.75	.717	.464	.455	.902
Obim struka	81.0	114.0	93.8	8.63	74.56	.638	.464	-.117	.902
Obim kukova	83.5	113.0	93.4	6.51	42.38	1.11	.464	2.31	.902

(nastavak na sledećoj strani)

(nastavak sa prethodne strane)

<b>Variable</b>	<b>Min</b>	<b>Max</b>	<b>Mean</b>	<b>SD</b>	<b>Variance</b>	<b>Skewness</b>		<b>Kurtosis</b>	
						<b>Stat</b>	<b>SE</b>	<b>Stat</b>	<b>SE</b>
Obim grudnog koša	94.0	119.0	103.5	7.64	58.40	.405	.464	-.107	.902
Obim natkoljenice	50.0	71.0	59.6	5.13	26.37	.362	.464	-.026	.902
Obim podlaktice	26.0	32.5	29.3	1.74	3.04	-.307	.464	-.656	.902
Kožni nabor trbuha	9.0	40.0	19.64	7.83	61.32	.773	.464	.273	.902
Kožni nabor grudi	3.0	10.0	5.1	1.36	1.86	1.80	.464	6.31	.902
Kožni nabor natkoljenice	4.0	18.0	7.0	3.77	14.24	1.75	.464	2.28	.902
Indeks tjelesne mase	22.3	37.2	27.3	3.58	12.85	.804	.464	.764	.902
Procenat tjelesnih masti	2.8	15.6	8.3	3.73	13.96	.443	.464	-.513	.902
Koeficijenat struka i kukova	0.9	1.08	0.9	.003	.001	.060	.464	.009	.902

Legenda: Min – minimalan rezultat; Max – maksimalan rezultat; Mean – aritmetička sredina; SD – standarda devijacija; Variance – varijansa; Skewness – koeficijent nagnutosti; Kurtosis – koeficijent zakrivljenosti.

Kada su u pitanju deskriptivni pokazatelji funkcionalnih parametara za subuzorak profesionalnih pripadnika Vojske Crne Gore, koji su prikazani u Tabeli 4, na osnovu vrijednosti skjunusa se konstatuje: za varijablu odnos forsiranog ekspiracijskog volumena u 1 sekundi i forsiranog vitalnog kapaciteta, negativna asimetrija sa dominacijom boljih rezultata, a za preostale tri va-

rijable, pozitivna asimetrija sa dominacijom slabijih rezultata. Negativna vrijednost kurtozisa za varijable forsirani vitalni kapacitet i odnos forsiranog ekspiracijskog volumena u 1 sekundi i forsiranog vitalnog kapaciteta, ukazuje na platikurtičnost i heterogenost rezultata. Kod ostalih varijabli se na osnovu pozitivnih vrijednosti kurtozisa zapažaju homogeni rezultati.

**Tabela 4.** Centralni i disperzionalni parametri funkcionalnih varijabli profesionalnih pripadnika Vojske Crne Gore

<b>Variable</b>	<b>Min</b>	<b>Max</b>	<b>Mean</b>	<b>SD</b>	<b>Variance</b>	<b>Skewness</b>		<b>Kurtosis</b>	
						<b>Stat</b>	<b>SE</b>	<b>Stat</b>	<b>SE</b>
FVC	4.3	6.7	5.5	.604	.366	.030	.464	-.390	.902
FEV1	3.4	6.0	4.4	.646	.417	.801	.464	.292	.902
FEV1/FVC	64.5	96.6	80.9	9.28	86.24	-3.73	.464	-.776	.902
PEF	3.5	12.5	7.3	2.53	6.41	.551	.464	.022	.902

Legenda: FVC – forsirani vitalni kapacitet; FEV1 – forsirani ekspiracijski volumen u 1 sekundi; FEV1/FVC – odnos forsiranog ekspiracijskog volumena u 1 sekundi i forsiranog vitalnog kapaciteta; PEF – vršni izdisajni protok; Min – minimalan rezultat; Max – maksimalan rezultat; Mean – aritmetička sredina; SD – standarda devijacija; Variance – varijansa; Skewness – koeficijent nagnutosti; Kurtosis – koeficijent zakrivljenosti.

Prema dobijenim rezultatima t-testa za morfološke pokazatelje regruta i profesionalnih pripadnika Vojske Crne Gore, prikazanih u Tabeli 5, konstatovane su statistički značajne razlike u morfološkim varijablama obim struka i obim podlakta.

Upoređivanjem srednjih numeričkih vrijednosti navedenih varijabli, uviđaju se sljedeće razlike u korist profesionalnih pripadnika Vojske Crne Gore: obim struka 6.16 cm i obim podlakta 1.12 cm.

**Tabela 5.** Upoređivanje morfoloških karakteristika regruta i profesionalnih pripadnika Vojske Crne Gore

<b>Variable</b>	<b>Rang</b>	<b>Mean</b>	<b>t</b>	<b>Sig</b>	<b>MD</b>
Visina tijela	Regruti	180.94	-.707	.483	-1.39
	Profesionalni vojnici	182.34			
Masa tijela	Regruti	84.02	-1.71	.092	-6.75
	Profesionalni vojnici	90.72			
Obim struka	Regruti	87.64	-2.31	.025*	-6.16
	Profesionalni vojnici	93.80			
Obim kukova	Regruti	90.38	-1.54	.129	-3.06
	Profesionalni vojnici	93.44			
Obim grudnog koša	Regruti	100.68	-1.31	.196	-2.87
	Profesionalni vojnici	103.56			
Obim natkoljenice	Regruti	58.38	-.868	.390	-1.23
	Profesionalni vojnici	59.61			
Obim podlaktice	Regruti	28.18	-2.24	.030*	-1.11

(nastavak na sledećoj strani)

(nastavak sa prethodne strane)

Variable	Rang	Mean	t	Sig	MD
	Profesionalni vojnici	29.30			
Kožni nabor trbuha	Regruti	17.80	-.842	.404	-1.84
	Profesionalni vojnici	19.64			
Kožni nabor grudi	Regruti	5.52	.985	.329	.400
	Profesionalni vojnici	5.12			
Kožni nabor natkoljenice	Regruti	8.56	1.63	.109	1.48
	Profesionalni vojnici	7.08			
Indeks tjelesne mase	Regruti	25.64	-1.75	.086	-1.74
	Profesionalni vojnici	27.38			
Procenat tjelesnih masti	Regruti	8.58	.296	.769	.284
	Profesionalni vojnici	8.30			
Koefficijent struka i kukova	Regruti	.96	-2.84	.006	-.034
	Profesionalni vojnici	.99			

Legenda: Mean – aritmetička sredina morfoloških varijabli regruta i profesionalnih pripadnika VCG; t – t vrijednost; Sig – signifikantnost; MD – razlike aritmetičkih sredina; \* – postojanje značajnih razlika.

Na osnovu dobijenih rezultata t-testa prikazanih u Tabeli 6, nisu konstatovane statistički značajne razlike za funkcionalne pokazatelje između regruta i profesionalnih pripadnika Vojske Crne Gore.

**Tabela 6.** Upoređivanje funkcionalnih sposobnosti regruta i profesionalnih pripadnika Vojske Crne Gore

Varijable	Rang	Mean	t	Sig	MD
FVC	Regruti	5.45	-.400	.691	-.074
	Profesionalni vojnici	5.53			
FEV1	Regruti	4.54	.400	.691	.075
	Profesionalni vojnici	4.46			
FEV1/FVC	Regruti	83.34	.893	.377	2.36
	Profesionalni vojnici	80.98			
PEF	Regruti	7.94	.865	.391	.592
	Profesionalni vojnici	7.35			

Legenda: FVC – forsirani vitalni kapacitet; FEV1 – forsirani ekspiracijski volumen u 1 sekundi; FEV1/FVC – odnos forsiranog ekspiracijskog volumena u 1 sekundi i forsiranog vitalnog kapaciteta; PEF – vršni izdisajni protok; Mean – aritmetička sredina funkcionalnih varijabli regruta i profesionalnih pripadnika VCG; t – t vrijednost; Sig – signifikantnost; MD – razlike aritmetičkih sredina.

## Diskusija

Tjelesna visina kao najpouzdaniji parametar praćenja rasta i razvoja kod regruta Vojske Crne Gore ima prosječnu vrijednost 180.9 cm, što je za 1.83 cm više u odnosu na dobijenu vrijednost tjelesne visine regruta Američke vojske (Steed et al., 2016). Napredovanje fenomena akceleracije u tjelesnoj visini vojnika, može se utvrditi poređenjem rezultata ovog istraživanja sa studijom sprovenom osamdesetih godina prošlog vijeka u Jugoslovenskoj Narodnoj Armiji (Todorović, 1989). Naime, prema ovoj studiji regruti iz Crne Gore su 1982. godine imali prosječnu visinu 176.6 cm, a 1989. godine 178.9 cm. Ukoliko uzmemo u obzir i rezultate dobijene u ovoj studiji, može se zaključiti da su utvrđene razlike potpuno saglasne sa konstatacijom antropologa, da je posljednjih pedeset godina donijelo evidentan rast u populaciji-prosjek 1-1.2 cm za jednu deceniju. Tjelesna masa i obim grudnog koša ispitanika ove studije, takođe su znatno viši u odnosu na rezultate studije Teodosijevića (1989) a razlike iznose 15.3 kg, odnosno 9 cm. Kada su u pitanju kožni nabori, koji su glavni indikatori procenata tjelesnih masti, mogu se konstatovati znatno niže vrijednosti kod regruta iz ove studije u odnosu na studiju Ivković i Pejić (1989).

Naime, upoređujući srednje vrijednosti kožnih nabora nadlakta u navedenim studijama, regruti Vojske Crne Gore imaju nižu vrijednost pomenute mjeru za 2.5 mm u odnosu na regrute Jugoslavenske Narodne Armije iz 1988. godine. U skladu sa tim, potvrđene su i znatno niže vrijednosti procenta tjelesnih masti kod naših regruta u odnosu na kandidate za Vojnu akademiju u Brazilu. Naime, upoređujući vrijednosti ove komponente tjelesnog sastava dobijene u studiji (Avila, Barros, Pascoa, & Tessutti, 2011) sa ekvivalentnom vrijednosti u našoj studiji, dolazimo do podataka da regruti Vojske Crne Gore imaju niže vrijednostima tjelesnih masti za 5.12 %. Obzirom da je koeficijent odnosa veličine struka i kukova, kod regruta VCG  $<0.95$ , oni imaju dominantno distribuciju masnog tkiva u donjem dijelu tijela. Takođe, u odnosu na procenat masnog tkiva, a u skladu sa Normama za procjenu masnog tkiva Kuperovog instituta (Kaminsky, 2013), regruti Vojske Crne Gore bi se mogli svrstati u kategoriju sa opisom ocjenom-veoma dobro. Kada govorimo o nivou uhranjenosti, na osnovu vrijednosti indeksa tjelesne mase (BMI) prema Kristoforović-Ilić (2001), oni se svrstavaju u kategoriju populacije sa prekomjernom tjelesnom težinom.

Prema prikazanim rezultatima funkcionalnih sposobnosti regruta Vojske Crne Gore, srednja vrijednost njihovog forsriranog vitalnog kapaciteta je za 0.8 l veća od referentne vrijednosti koju je utvrdio Guyton (1985). Konstatuje se da forsrirani ekspiracijski volumena u 1 sekundi čini 83.3% vitalnog kapaciteta, što je odlika zdravih osoba sa dobrom respiratornom funkcijom (Medved i sar., 1979). Ovaj rezultat predstavlja takozvani Tiffenau indeks, po

kojem se za normalne vrijednosti (referentne vrijednosti) smatraju one koje su veće od 70% (Davidović i sar., 1975). Vrijednosti vršnog izdisajnog protoka, ukazuju na dobro stanje respiratornih puteva.

Kada su u pitanju morfološki pokazatelji profesionalnih pripadnika Vojske Crne Gore (Tabela 7), može se konstatovati njihova apsolutna dominacija po pitanju tjelesne visine u odnosu na profesionalne pripadnike stranih armija.

**Tabela 7.** Poređenje srednjih vrijednosti tjelesne visine profesionalnih pripadnika Vojske Crne Gore i stranih vojski

Upoređivane vojske	TV (VCG)	TV (druga vojska)	Upoređeno sa studijama
Vojske Crne Gore - Vojska Finske	182,3	180,0	Kyrolainen i sar., 2008
Vojske Crne Gore - Vojska SAD	182,3	176,0	Steed i sar., 2016
Vojske Crne Gore - Vojska Srbije	182,3	180,2	Glavač, 2015
Vojske Crne Gor - Vojska Kanade	182,3	178,0	Tingelstad i sar., 2016
Vojske Crne Gore - Vojska Turske	182,3	173,0	Tugcu i sar., 2016
Vojske Crne Gore - Vojska Belgije	182,3	177,5	Mullie i sar., 2008

Legenda: VCG – Vojska Crne Gore; TV – Visina tijela

Takođe, primjećuje se razlika u njihovu korist i kada je u pitanju određeni broj antropometrijskih mjera u odnosu na profesionalne pripadnike Vojske Srbije, tjelesna masa je viša za 17.0 kg, obim struka za 13.1 cm (Raković-Savčić, 1999); obim grudnog koša za 0.7 cm (Glavač, 2015). Međutim, kod profesionalnih pripadnika Vojske Crne Gore je zabilježen niži procenat tjelesnih masti za 3.98% u odnosu na kadete Vojne akademije u Beogradu (Raković-Savčić, 1999), iako se oni s obzirom na vrijednost indeksa tjelesne mase (BMI), a prema Kristoforović-Ilić (2001), svrstavaju u populaciju sa prekomjernom tjelesnom težinom. Kako je koeficijent odnosa veličine struka i kukova, kod profesionalnih pripadnika Vojske Crne Gore <0.95, važno je naglasiti da oni imaju dominantno distribuciju masnog tkiva u donjem dijelu tijela. Ovako distribuirano masno tkivo neće imati negativne efekte na parametre respiratorne funkcije, jer rezultati studije Harik-Khan et al. (2001) upućuju na to da masno tkivo skladišteno u gornjem dijelu tijela i trbušnoj duplji najvjerojatnije direktno sprečava spuštanje dijafragme, povećavajući pritisak na zidove grudnog koša i vodeći do restiktivnog respiratornog poremećaja, što kod profesionalnih pripadnika Vojske Crne Gore nije slučaj.

Dobijene vrijednosti funkcionalnih pokazatelja kod profesionalnih vojnika Vojske Crne Gore, ukazuju da je srednja vrijednost njihovog forsriranog vitalnog kapaciteta za 0.9 l veća od referentne vrijednosti koju je utvrdio Guyton (1985). Evidentno je da Tiffenau indeks iznosi 80.9%, tako da se za ovaj subuzorak ispitanika konstatuje da ga čine osobe sa dobrom respiratornom funkcijom. Takođe, vrijednosti vršnog izdisajnog protoka, ukazuju na zadovoljavajuće stanje respiratornih puteva.

Primjenom t-testa, utvrđeno je da između regruta i profesionalnih pripadnika Vojske Crne Gore ne postoji statistički značajna razlika kod većine primijenjenih morfološkim pokazatelja. Ipak, pomenuta razlika se javila kod morfoloških mjera obim struka i obim podlakta u korist profesionalnih pripadnika Vojske Crne Gore. Takođe, iako nije na nivou statističke značajnosti, primjećuje se razlika i u tjelesnoj masi, koja je za 6.7 kg veća kod profesionalnih vojnika. Obzirom na podudarnost kod pokazatelja procenat tjelesnih masti, može se konstatovati da je razlika u tjelesnoj masi nastala kao rezultat različitih vrijednosti ostalih parametara tjelesne kompozicije.

U skladu sa dobijenim rezultatima, moguće je izvesti sljedeće zaključke: Crnogorski vojnik je dominantan po pitanju tjelesne visine u odnosu na vojnike iz armija regionala i svijeta.

Ovakvi podaci nijesu iznenadjujući, obzirom da je potvrđeno da su stanovnoci Crne Gore među najvišim ljudima na Svetu (Bjelica et al., 2012; Popovic, 2017; Masanovic, Bavcevic, & Prskalo, 2019). Ustanovljeno je da su regruti i profesionalni pripadnici Vojske Crne Gore do 25 godina starosti, zdrava populacija bez pojave gojaznosti i sa dobrim stanjem respiratorne funkcije. Shodno tome, izvodi se zaključak da oni bez opasnosti po svoje zdravlje mogu profesionalno i efikasno obavljati zahtjevne višenamjenske vojne zadatke. To je sa apekta organizacije i realizacije obuke veoma bitno, kako bi ona u krajnjem dala vojnika koji će prema svim standardima biti kompatibilan sa vojnikom najrazvijenijih zemalja članica Sjeverno-Atlantske alijanse. Takođe, utvrđeno je da je obzirom na sličnost u ispitivanim sistemima morfološkog prostora i funkcionalnih sposobnosti između regruta i profesionalnih pripadnika Vojske Crne Gore, izvršena dobra selekcija prilikom prijema prve generacije vojnika na dobrovoljnem služenju vojnog roka. Ovim se daje jasan signal nadležnim službama u vojsci, da selekciju nastave obavljati po utvrđenim normativima i standardima.

Rezultati ovog istraživanja predstavljaju doprinos u pravcu rasvjetljavanja stanja morfoloških i funkcionalnih parametara vojnika u Vojske Crne Gore. Značajno bi bilo sprovesti obimniju studiju u kojoj bi se vršile komparacije morfoloških i funkcionalnih pokazatelja vojnika prema starosnoj dobi, vidu vojske i vojnoj specijalnosti. Obzirom na veličinu ispitivanog uzorka, nije moguće donijeti dodatne zaključke, koji bi bili u skladu sa statističkom i kineziološkom zakonomjernošću. Ipak, to ne umanjuje vrijednost ove studije, koja je zapravo ukazala na značaj praćenja morfološkog prostora i funkcionalnih sposobnosti vojnika.

#### Acknowledgements

There are no acknowledgements.

#### Conflict of Interest

The authors declare that there are no conflicts of interest.

**Received:** 2 October 2019 | **Accepted:** 1 December 2019 | **Published:** 10 January 2020

#### References

- Abt, J., Perisweing, K., Nagai, T., Sell, T., Wirt, M., & Lephart, S. (2016). Effects of Age and Military Service on Strength and Physiological Characteristics of U.S. Army Soldiers. *Military medicine*, 181(2), 173-179.
- Avila, J.A., Barros Lima Filho, P.D., Pascoa, M.A., & Tessutti, L. (2013). Effect of 13 Weeks of Military Exercise Training on the Body Composition and Physical Performance of EsPCEx Students. *Revista Brasileira de Medicina*

- do Esporte, 19(5), 363-366.*
- American Thoracic Society (1991). Lung function testing: selection of reference values and interpretative strategies. *American Review of Respiratory Disease, 144(5), 1202-1218.*
- Babcock, C., Kirby, T., McCarroll, M., & Devor, S. (2006). A Comparison of Military Circumference Equations to Skinfold-Based Equations to Estimate Body Composition. *Military medicine, 171(2), 60-63.*
- Banjević, B. (2012). *Modelne vrijednosti motoričkog i morfološkog statusa pripadnika Vazduhoplovne baze Vojske Crne Gore i njihov uticaj na kompleksne motorne aktivnosti*. Neobjavljena magistarska teza. Nikšić: Fakultet sporta i fizičkog vaspitanja.
- 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.*
- Collins, L., Hoberty, P., Walker, J., Fletcher, E., & Peiris, A. (1995). The effect of body fat distribution on pulmonary function tests. *Chest, 107(5), 1298-1302.*
- Craword, K., Fleishman, K., John, P., Sell, T., Lovalekar, M., Nagai, T., Deluzio, J., Rowe, R., & Lephart, S. (2011). Less Body Fat Improves Physical and Physiological Performance in Army Soldiers. *Military medicine, 176(6), 35-43.*
- Davidović, J., Rajšić, R., Radović, A., Debičić, R., Rišavi, A., Kolak, A., Popović, R., & Dželajlja, S. (1975). *Vazduhoplovna medicina*. Beograd: Komanda ratnog vazduhoplovstva i protiv-vazdušne odbrane.
- De Lorenzo, A., Maiolo, C., Mohamed, E., Andreoli, A., Petrone, P., & Rossi, P. (2001). Body composition analysis and changes in airways function in obese adults after hypocaloric diet. *Chest, 119(5), 1409-1415.*
- Dockery, D., Ware, J., Ferris, G., Glicksberg, D., Fay, M., Spiro, A., & Speizer, F. (1985). Distribution of forced expiratory volume in one second and forced vital capacity in healthy, white, adult never-smokers in six U.S. cities. *American Review of Respiratory Disease, 131(4), 511-520.*
- Glavač, B. (2015). *Motoričke sposobnosti, morfološki status i životne navike kod pripadnika Vojske Srbije*. Neobjavljena doktorska disertacija. Beograd: Fakultet sporta i fizičkog vaspitanja.
- Guyton, A. (1985). Medicinska fiziologija. Beograd-Zagreb: Medicinska knjiga.
- Harik-Khan, R., Wise, R., & Fleg, J. (2001). The effect of gender on the relationship between body fat distribution and lung function. *Journal of Clinical Epidemiology, 54(4), 399-406.*
- Ivković, Z., & Pejić, R. (1989). Uticaj obuke na razvijenost, uhranjenošć i fizičku sposobnost vojnika. Beograd: Sanitetska uprava GŠ JNA-Savezni sekretarijat za narodnu odbranu.
- Jukić, I., Vučetić, V., Aračić, M., Bok, D., Dizdar, D., Sporiš, G., & Križanić, A. (2008). *Dijagnostika kondicijske pripremljenosti vojnika*. Zagreb: Kineziološki fakultet.
- Kaminsky, A. (2013). *Priručnik za procjenu fizičke forme povezane sa zdravljem*. Beograd: Data Status.
- Kaur, A., Subhedar, R., Dave, P., Mishra, P. & Sharma, D. (2015). Physiotherapeutic study analyzing the relationship between body composition and lung function. *International Journal of Physiotherapy and Research, 3(5), 1233-1238.*
- Kristoforović-Ilić, M. (2001). *Higijena-priručnik sa praktikumom*. Novi Sad: OrtoMedics.
- Kyrolainen, H., Hakkinen, K., Kautiainen, H., Santtila M., Pihlainen, K., & Hakkinen, A. (2008). Physical fitness, BMI and sickness absence in male military personnel. *Occupational Medicine, 58(4), 251-256.*
- Lučić, J., & Aračić, M. (2008). Differences of the morphological characteristics of the members of the Croatian armed forces: a systematic review. In *Proceedings book of the 5<sup>th</sup> International scientific conference on kinesiology (387-391)*. Zagreb: Faculty of Kinesiology.
- Marić, L., & Krsmanović, B. (2010). Razlike u antropometrijskim karakteristikama studenata Vojne akademije u toku školovanja. *Glasnik Antropološkog Društva Srbije, 45, 349-355.*
- Marić, L., Krsmanović, B., Mraović, T., Gogić, A., Sente, J., & Smajić, M. (2013). The effectiveness of physical education of the Military Academy cadets during a 4-year study. *Vojnosanitetski pregled, 70(1), 16-20.*
- Marrioti, A., & Scott, G. (1992). *Body Composition Physical Performance: Applications for the Military Services*. Washington: DC National Academy Press.
- Manasović, B., Bavcević, T., & Prskalo, I. (2019). Regional differences in adult body height in Kosovo. *Montenegrin Journal of Sports Science and Medicine, 8(1), 69-76*. doi: 10.26773/mjssm.190310
- Medved, R., Heimer, S., Kesić, B., Pavišić-Medved, V. (1987). *Sportska medicina*. Zagreb: JUMENA.
- Mullie, P., Vansant, G., Mieke, H., Clarys, P., & Degraeve, E. (2008). Evaluation of Body Fat Estimated from Body Mass Index and Impedance in Belgian Male Military Candidates: Comparing Two Methods for Estimating Body Composition. *Military medicine, 173(3), 266-270.*
- Popović, S. (2017). Local Geographical Differences in Adult Body Height in Montenegro. *Montenegrin Journal of Sports Science and Medicine, 6(1), 81-87.*
- Raković-Savčić, Lj. (1999). *Antropometrijski pokazatelji gojaznosti u ciljanom otkrivanju rizika od kardiovaskularnih oboljenja starešina*. Neobjavljena doktorska disertacija. Beograd: VMA.
- Steed, C., Krull, B., Morgan, A., Tucker, R., & Ludy, M-J. (2016). Relationship between body fat and physical fitness in Army ROTC cadets. *Military medicine, 181(9), 1007-1012.*
- Tingelstad, H., Theoret, D., Spicovck, M., & Haman, F. (2016). Explaining Performance on Military Tasks in the Canadian Armed Forces: The Importance of Morphological and Physical Fitness Characteristics. *Military medicine, 181(11-12), 1623-1629.*
- Todosijević, M. (1989). *Visoka psihofizička sposobnost regruta potrebna za kvalitetnu popunu većine rođova i službi JNA i uticaj ograničeno sposobnih*. Beograd: Savezni sekretarijat za narodnu odbranu.
- Tugcu, H., Ozaslan, A., Ozaslan, I., & Koc, S. (2006). Estimation of Stature from Upper Extremity. *Military medicine, 171(4), 288-291.*
- Vogel, J., & Friedl, K. (1992). *Body Composition and Physical Performance Applications for Military Services*. Washington: National Academies Press.



**ORIGINAL SCIENTIFIC PAPER**

# Body Composition of Soccer Players of Montenegro and Bosnia and Herzegovina

Jovan Gardasevic<sup>1</sup>, Dusko Bjelica<sup>1</sup>, Ivan Vasiljevic<sup>1</sup>, Marin Corluka<sup>2</sup>

<sup>1</sup>University of Montenegro, Faculty for Sport and Physical Education, Niksic, Montenegro, <sup>2</sup>University of Mostar, Faculty of Mathematics and Science Education, Mostar, Bosnia and Herzegovina

## Abstract

The aim of this research was to determine the differences among the soccer players of the soccer club in Montenegro, FC Buducnost and the soccer players of the soccer club in Bosnia and Herzegovina FC Siroki Brijeg, in the anthropometric characteristics and body composition. A sample of 52 subjects was divided into two sub-samples. The first sub-sample of the subjects consisted of 30 soccer players of FC Buducnost of the average age  $22.73 \pm 4.33$ , the champions of the Montenegro Championship in the season 2016/17, while the other sub-sample consisted of 22 players of FC Siroki Brijeg of the average age of  $24.00 \pm 6.22$ , the champions of the Cup of Bosnia and Herzegovina in the season 2016/17. Soccer players were tested immediately after the end of the competition season 2016/17. Anthropometric characteristics in the body composition were evaluated by a battery of 10 variables: body height, body weight, waist circumference, triceps skinfold, biceps skinfold, skinfold of the back, abdominal skinfold, body mass index, fat percentage and muscle mass. The significance of the differences between the soccer players of the top two soccer clubs in the anthropometric characteristics and variables for assessing body composition was determined by a t-test for independent samples. It was found that the soccer players of the two mentioned clubs have statistically significant differences by the three variables that estimate the triceps skinfold, biceps skinfold and abdominal skinfold, in a favor of FC Siroki Brijeg.

**Keywords:** soccer, FC Buducnost, FC Siroki Brijeg, Anthropometric Characteristics, Body Composition

## Introduction

A soccer game is said to be the most important secondary thing in the world, it gathers huge masses at stadiums and in front of TVs (Gardašević i Vasiljević, 2016; Gardašević, Bjelica, Popović, & Milašinović, 2016). It is a highly dynamic and fast team game which, with its richness of movement, falls under category of polystructural sports games (Gardašević & Bjelica, 2014; Gardasevic, Bjelica, & Vasiljevic, 2017a). Soccer is a sport that is characterized by numerous and various complex and dynamic kinesiological activities which are then characterized by either cyclical (Gardašević, Vasiljević, i Bojančić, 2015; Sermaxhaj, Popović, Bjelica, Gardasevic, & Arifi, 2017; Gardasevic, Bjelica, & Vasiljevic, 2017b) or acyclical movement (Gardase-

vic, 2015; Gardašević, Bjelica, i Vasiljević, 2016a; Gardašević, Bjelica, i Vasiljević, 2016b; Gardasevic, Bjelica, Milasinovic, i Vasiljevic, 2016; Gardasevic, Popovic, & Bjelica, 2016). In soccer, top score can be achieved only under conditions of well-programmed training process (Gardasevic, Bjelica, & Vasiljevic, 2020). High quality management of the training process depends on the knowing of the structure of certain anthropological capabilities and player's characteristics, as well as their development (Gardašević & Bjelica, 2018; Bjelica, Gardasevic, Vasiljevic, & Corluka, 2018). Various researches are to be done in order to establish certain principles and norms for the transformational processes of the anthropological characteristics important for soccer (Gardašević, Bjelica, Georgiev, & Popović, 2012); with anthropomet-

Correspondence:

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

ric characteristics and body composition among them as expected. Findings regarding anthropometric characteristics and body composition are of crucial importance for complex sports games such as soccer (Gusic, Popovic, Molnar, Masanovic, & Radakovic, 2017). The anthropometric space is defined by the longitudinal dimension of the skeleton, the transversal dimensionality of the skeleton, the mass and volume of the body (Gardasevic, Bjelica, Vasiljevic, & Corluka, 2019; Masanovic, Bavcevic, & Bavcevic, 2019). The purpose of knowing anthropometric characteristics is to improve skills in many sports (Carter & Heath, 1990; Masanovic, Milosevic, & Corluka, 2018). The anthropometric status of top level athletes is relatively homogeneous, depending on the sport, and it can be defined as a model of athletic achievement (Masanovic, Corluka, & Milosevic, 2018; Corluka, Bjelica, Gardasevic, & Vasiljevic, 2019; Masanovic, 2018; Masanovic, 2019; Arifi, Bjelica, & Masanovic, 2019). Research on anthropometric characteristics and body composition among athletes of different sports indicates that athletes of different sports have their own specific characteristics. Muscle mass improves performance in activities that require muscular strength and endurance, but also in those that require enviable aerobic ability (Ramadan & Byrd, 1987; Green, 1992; Rico-Sanz, 1998).

Today, soccer is certainly the number one sport in the world for its view and popularity (Gardašević, Georgiev, & Bjelica, 2012; Gardasevic, Bjelica, Vasiljevic, Arifi, & Sermaxhaj, 2019), and the same applies to Montenegro and Bosnia and Herzegovina (Bjelica, Gardasevic, Vasiljevic, Arifi, & Sermaxhaj, 2019). The two clubs that are at the top of the First Montenegrin Telecom League and Premier League of Bosnia and Herzegovina, in the 2016/17 competitive season, they both have achieved a staggering success, FC Buducnost was the champion of Montenegro and FC Siroki Brijeg was the winner of the Cup of Bosnia and Herzegovina. Based on these two trophies that they have won at the end of the competition season, both clubs have acquired the right to play on the international soccer scene within the framework of UEFA's Champions League qualification and UEFA's Europa League qualification. It became as interesting for researchers to determine the models of anthropometric characteristics and body composition of the players who play for these clubs as to determine the differences among them.

The aim of this research was to determine body composition and anthropometric characteristics of elite soccer players, players of FC Buducnost who compete in the First Montenegrin Telecom League and players of FC Siroki Brijeg who compete in the Telecom Premier League of Bosnia and Herzegovina. After which, compare the variables between these soccer players and determine the possible differences between them.

## Method

### Sample of subjects

A sample of the subjects consists of a total of 52 top-level senior

soccer players who performed in the First Montenegrin Telecom League and the Premier League of Bosnia and Herzegovina, divided into two sub-samples. The first one consists of 30 soccer players of FC Buducnost of the average age  $22.73 \pm 4.33$ , the champions of the Montenegro Championship in the season 2016/17, and the second one that consists of 22 players of FC Siroki Brijeg of the average age of  $24.00 \pm 6.22$ , the winner of the Cup of Bosnia and Herzegovina in the season 2016/17. The soccer players were tested immediately after the 2016/17 season ended.

### Sample of measures

Anthropometric research has been carried out with respect to the basic rules and principles related to the selection of measuring instruments and measurement techniques standardized in accordance with the International Biological Program guidelines. For the purpose of this study, 7 anthropometric measures have been taken: body height, body weight, waist circumference, triceps skinfold, biceps skinfold, skinfold of the back and abdominal skinfold, and 3 body composition assessment variables: BMI-body mass index, fat percentage and muscle mass. Anthropometer, caliper, and measuring tape were used for anthropometric measurements. To evaluate the body composition, Tanita body fat scale - model BC-418MA, was used. The principle of this scale is based on indirect measurement of the body composition; a safe electrical signal is transmitted through the body via electrodes located in the standalone unit. The Tanita Scale, thanks to its athletics mode, enables athletes to closely monitor their body weight, health condition and form with all relevant parameters.

### Method of data processing

The data obtained through the research are processed by descriptive and comparative statistical procedures. For each variable, central and dispersion parameters, as well as asymmetry and flattening measures are processed. Differences in anthropometric characteristics and the body composition of the soccer players of these two clubs were determined by using a discriminatory parametric procedure with t-test for small independent samples, with statistical significance of  $p < 0.05$ .

## Results

In Tables 1 and 2, basic descriptive statistical parameters of anthropometric variables and body composition of the soccer players of the two clubs, where the values of central measurements and dispersion tendencies are calculated, are shown: Arithmetic mean (Mean), Standard deviation (S.D.), Variance, Minimal (Min) i Maximal (Max) values, coefficient of Curvature (Skewness) and Elongation (Kurtosis). First, the central and dispersion parameters of the variables were analyzed to evaluate the anthropometric characteristics and body composition of the soccer players of FC Buducnost (Table 1).

**Table 1.** Central and dispersion parameters of variables for assessment of anthropometric characteristics and body composition of soccer players of FC Buducnost (N=30)

Variables	Min	Max	Mean±SD	Variance	Skewness	Kurtosis
Body height	171.1	196.0	181.96±5.89	34.75	.34	-.26
Body weight	64.7	96.9	78.03±8.52	72.63	.70	-.31
Waist circumference	74.0	95.0	83.43±5.23	27.36	.45	-.26
Triceps skinfold	4.0	13.6	7.79±2.45	6.01	.48	-.27
Biceps skinfold	3.2	8.2	5.28±1.29	1.69	.54	-.56
Skinfold of the back	3.6	18.6	9.81±2.89	8.39	.83	2.14
Abdominal skinfold	6.4	18.2	10.22±2.90	8.43	1.04	.94
Body mass index	21.1	27.1	23.49±1.45	2.11	.87	.76
Fat percentage	5.2	16.0	9.98±2.76	7.63	.16	-.47
Muscle mass	34.7	46.9	39.54±3.69	13.63	.41	-.13

Note: Min – minimal value; Max – maximal value; Mean – average value; SD – standard deviation

Based on the central and dispersion parameters, the values of the skewness and the kurtosis, it can be noted that all the variables are placed within the normal distribution boundaries. Generally, according to all statistical parameters, it can be concluded that here we have some top soccer players and that there is a normal distribution in all variables. By the value of the skewness, it can be noticed

that in the variable of the abdominal skinfold, there was a slight inclination on the side of the lower results, which is good because subcutaneous fat is a disrupting factor for professional athletes. Table 2 showed the central and dispersion parameters of the variables were analyzed to evaluate the anthropometric characteristics and body composition of the soccer players of FC Siroki Brijeg.

**Table 2.** Central and dispersion parameters of variables for assessment of anthropometric characteristics and body composition of soccer players of FC Siroki Brijeg (N=22)

Variables	Min	Max	Mean±SD	Variance	Skewness	Kurtosis
Body height	167.2	195.5	183.29±6.75	45.59	-.59	.34
Body weight	64.6	87.9	77.60±6.57	43.12	-.46	-.52
Waist circumference	78.0	92.0	83.77±3.84	14.75	.59	.14
Triceps skinfold	4.0	9.2	5.88±1.17	1.37	1.06	1.81
Biceps skinfold	3.6	6.6	4.58±.75	.57	1.00	1.01
Skinfold of the back	6.6	13.6	8.96±1.75	3.05	.92	1.14
Abdominal skinfold	4.8	13.6	8.51±2.49	6.19	.45	-.69
Body mass index	20.7	26.8	22.99±1.51	2.28	.37	.34
Fat percentage	4.2	14.5	9.84±2.69	7.22	-.38	-.18
Muscle mass	33.1	46.1	39.57±3.26	10.61	-.17	.23

Based on the central and dispersion parameters, the values of skewness and kurtosis of the soccer players of FC Siroki Brijeg, it can be stated that all the variables are within the normal distribution boundaries and that the values are very similar to those of the soccer players of FC Buducnost. It can also be stated that the soccer players of FC Buducnost are younger on average. It can also be concluded that almost all variables of quantitative value are better with soccer players of FC Siroki Brijeg. However, a com-

parative statistical procedure, t-test (Table 3), will show whether it is statistically significant. By the value of the skewness, it can be noticed that in the all variables of the skinfolds there was a slight inclination on the side of the lower results, which is good because subcutaneous fat is a disrupting factor for professional athletes. In order to determine whether there are statistically significant differences in the analyzed variables in the top soccer players of these two clubs, the statistical procedure t-test (Table 3) was applied.

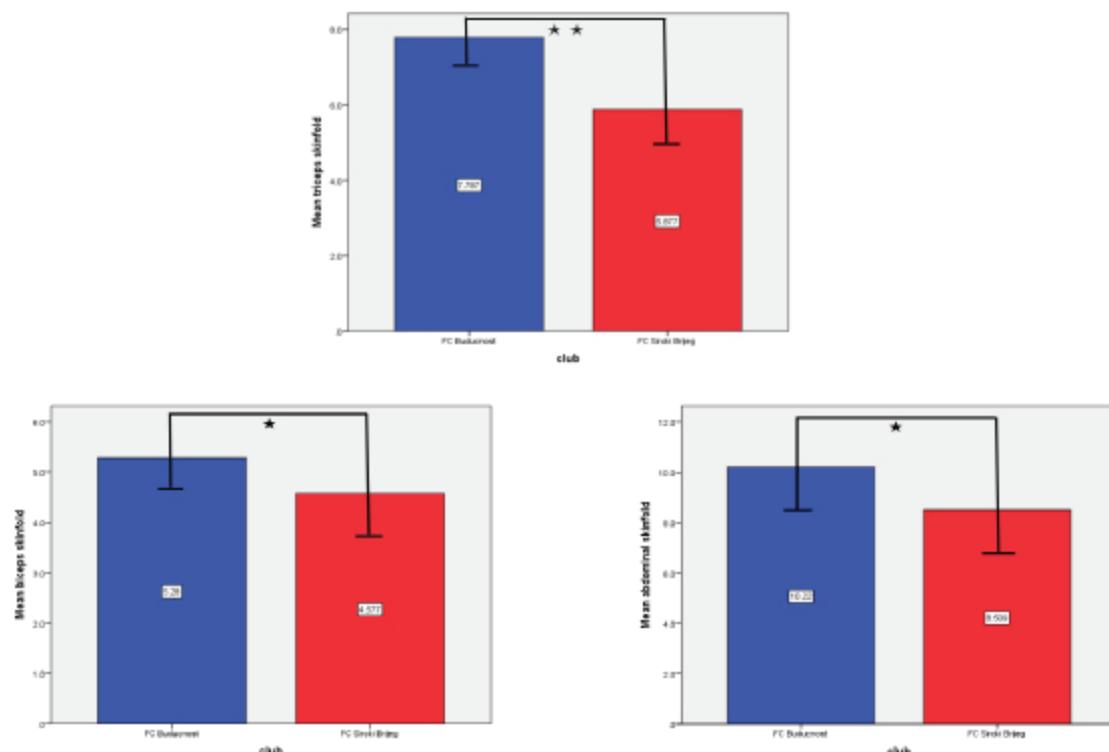
**Table 3.** Differences between the arithmetic mean of variables for the evaluation of anthropometric characteristics and body composition of soccer players of FC Buducnost (N=30) and FC Siroki Brijeg (N=22)

Variables	Club	Mean±SD	MD	t-test	Sig
Body height	FC Buducnost	181.96±5.89	-1.33	-.754	.455
	FC Siroki Brijeg	183.29±6.75			
Body weight	FC Buducnost	78.03±8.52	0.43	.196	.846
	FC Siroki Brijeg	77.60±6.57			
Waist circumference	FC Buducnost	83.43±5.23	-0.34	-.257	.798
	FC Siroki Brijeg	83.77±3.84			
Triceps skinfold	FC Buducnost	7.79±2.45	1.91	3.376	.001
	FC Siroki Brijeg	5.88±1.17			
Biceps skinfold	FC Buducnost	5.28±1.29	0.70	2.269	.028
	FC Siroki Brijeg	4.58±.75			
Skinfold of the back	FC Buducnost	9.81±2.89	0.85	1.218	.229
	FC Siroki Brijeg	8.96±1.75			
Abdominal skinfold	FC Buducnost	10.22±2.90	1.71	2.227	.030
	FC Siroki Brijeg	8.51±2.49			
Body mass index	FC Buducnost	23.49±1.45	0.50	1.195	.238
	FC Siroki Brijeg	22.99±1.51			
Fat percentage	FC Buducnost	9.98±2.76	0.14	.186	.853
	FC Siroki Brijeg	9.84±2.69			
Muscle mass	FC Buducnost	39.54±3.69	-0.03	-.030	.976
	FC Siroki Brijeg	39.57±3.26			

Note: Mean – average value; SD – standard deviation; MD - mean difference; Sig – significant difference

Based on the obtained values of t-test results, it can be noted that there are statistically significant differences in three variables; in one variable at  $p<0.01$  (triceps skinfold), and in two variables at  $p<0.05$  (biceps skinfold and abdominal skinfold). It can be stated that the

soccer players of FC Buducnost have statistically significant higher triceps skinfold, biceps skinfold and abdominal skinfold than the soccer players of FC Siroki Brijeg (Figure 1). In all other variables the differences are negligible and not statistically significant.



Note: \*\* - significant difference at level  $p<.01$ ; \* - significant difference at level  $p<.05$

**Figure 1.** Statistically significant differences between soccer players of FC Buducnost and soccer players of FC Siroki Brijeg in three variables

## Discussion

The aim of this study was to determine the difference in the anthropometric characteristics and body composition of the top soccer players of the champions' in Montenegro FC Buducnost and the top soccer players of the winners' Cup in Bosnia and Herzegovina FC Siroki Brijeg. A sample of 52 respondents was divided into two sub-samples. The first one consists of 30 soccer players of FC Buducnost of the average age  $22.73 \pm 4.33$ , who were a statistically younger than the 22 soccer players of FC Siroki Brijeg, who made the second sub-sample of  $24.00 \pm 6.22$  age on average. The results were obtained by using a battery of 10 tests in the area of anthropometric characteristics and body composition. By looking into the basic descriptive statistical parameters, it can be concluded that we have examined professional sportsmen indeed. It can be noticed that the soccer players of both clubs are of the approximately similar mean values of the variables analyzed, which is not surprising because these are the top two soccer clubs in Montenegro and Bosnia and Herzegovina, a state where there is also a great concentration of good soccer players. The t-test results showed that the soccer players of the two mentioned clubs have statistically significant differences by the three variables that estimate the triceps skinfold, biceps skinfold and abdominal skinfold, in a favor of FC Siroki Brijeg. The variable in which a statistically significant difference has been found is a variable that estimates abdominal skinfold, where the soccer players of FC Buducnost have a statistically higher value than the soccer players of FC Siroki Brijeg. Also, at the variables of triceps skinfold and biceps

skinfold, soccer players of FC Siroki Brijeg have shown statistically better values because a smaller number means a better result when the disrupting factor of subcutaneous fat on playing soccer is taken into account. Very similar characteristics of soccer players were obtained in the region, which shows that soccer players have similar the anthropometric characteristics and body composition in the whole region (Gardasevic, Bjelica, Popovic, Vasiljevic, & Milosevic, 2018; Bjelica, Gardasevic, & Vasiljevic, 2018; Corluka & Vasiljevic, 2018; Bjelica & Gardasevic, 2019; Gardasevic, Bjelica, & Vasiljevic, 2019a; Gardasevic, Bjelica, & Vasiljevic, 2019b; Gardasevic & Bjelica, 2020; Bjelica, Gardasevic, Vasiljevic, Jeljkovic, & Covic, 2019).

For other variables, all values are better for soccer players of FC Siroki Brijeg, although, insignificantly for statistics, which indicates that these soccer players have very similar anthropometric parameters and body composition, which is again, not surprising, considering that these two soccer clubs are the best in their countries in the 2016/17 competitive season. The values obtained in this research can be useful for coaches of these soccer clubs for making a comparison of their soccer players with others and formulate their work in a way that enables reduction of those parameters that are not good, and raise those that are good to a higher level. That will surely make their soccer players even better and more successful. Also, both clubs should turn to other researches and check the functional-motoric status, psychological preparation as well as tactical training of their soccer players and analyze whether there is room for their improvement. The

results obtained in this research can serve as model parameters for the estimated variables for soccer players of all other soccer clubs in Montenegro and Bosnia and Herzegovina, because the soccer players that have been analyzed here, were among the best and the most successful soccer players in those two countries at the end of the competitive season 2016/17.

### Acknowledgements

There are no acknowledgements.

### Conflict of Interest

The authors declare that there is no conflict of interest.

**Received:** 10 July 2019 | **Accepted:** 13 September 2019 | **Published:** 10 January 2020

### References

- Arifi, F., Bjelica, D., & Masanovic, B. (2019). Differences in anthropometric characteristics among junior soccer and handball players. *Sport Mont*, 17(1), 45-49.
- Bjelica, D., Gardasevic, J., & Vasiljevic, I. (2018). Differences in the Anthropometric characteristics and body composition of soccer players FC Sutjeska and FC Mladost in Montenegro. *Journal of Anthropology of Sport and Physical Education*, 2(2), 31-35. doi: 10.26773/jaspe.180406
- Bjelica, D., Gardasevic, J., Vasiljevic, I., & Corluka, M. (2018). Body composition and anthropometric measures of footballers, cup winners of Montenegro and Bosnia and Herzegovina. *Journal of Anthropology of Sport and Physical Education*, 2(4), 3-7. doi: 10.26773/jaspe.181001
- Bjelica, D., & Gardasevic, J. (2019). Body composition and anthropometric measures of soccer players, champions of Montenegro and Bosnia and Herzegovina. *Book of Abstracts of the 16<sup>th</sup> Annual Scientific Conference of Montenegrin Sports Academy "Sport, Physical Activity and Health: Contemporary Perspectives"* (73-74), Podgorica: Montenegrin Sports Academy.
- Bjelica, D., Gardasevic, J., Vasiljevic, I., Arifi, F., & Sermakhaj, S. (2019). Anthropometric measures and body composition of soccer players of Montenegro and Montenegro. *Journal of Anthropology of Sport and Physical Education*, 3(2), 29-34. doi: 10.26773/jaspe.190406
- Bjelica, D., Gardasevic, J., Vasiljevic, I., Jeleskovic, E., & Covic, N. (2019). Body Composition and Morphological Characteristics of Soccer Players in Bosnia and Herzegovina. *Kinesiologija Slovenica*, 25(1), 5-13.
- Cartier, J.E.L., & Heath, B.H. (1990). *Somatotyping—Development and application*. Cambridge, United Kingdom: Cambridge University Press.
- Corluka, M., & Vasiljevic, I. (2018). Differences in the Anthropometric characteristics and body composition of soccer players in Montenegro. *Journal of Anthropology of Sport and Physical Education*, 2(1), 3-7. doi: 10.26773/jaspe.180101
- Corluka, M., Bjelica, D., Gardasevic, J., & Vasiljevic, I. (2019). Anthropometric characteristics of elite soccer players from Bosnia and Herzegovina and Montenegro. *Journal of Anthropology of Sport and Physical Education*, 3(3), 11-15. doi: 10.26773/jaspe.190702
- Gardašević, J., Georgiev, G., & Bjelica, D. (2012). Qualitative changes of basic motor abilities after completing a six-week training programme. *Acta Kinesiologica*, 6(1), 70-74.
- Gardašević, J., Bjelica, D., Georgiev, G., & Popović, S. (2012). Transformation of situational motor abilities with soccer players—cadets. *Proceeding book, XVI International Scientific Congress "Olympic Sports and Sport for All" & VI International Scientific Congress „Sport, Stress, Adaptation”* (373-377), Sofia: National Sports Academy "Vassil Levski".
- Gardašević, J., & Bjelica, D. (2014). The effects of the training in the preparation period on the dribbling speed with fifteen years old soccer players. *Book of Abstracts of the 11th International Scientific Conference on Transformation Process in Sport "Sport Performance"* (22-23), Podgorica: Montenegrin Sports Academy.
- Gardašević, J., Vasiljević, I., & Bojančić, D. (2015). Six-week preparation period and its effects on coordination transformation with soccer players under 16. *Book of Abstracts 11th International Scientific Conference Management, Sport, Olympism* (36), Beograd: Fakultet za menadžment u sportu, Alfa univerzitet.
- Gardasevic, J. (2015). The effects of the training in the preparation period on the agility transformation with cadet level soccer players. *Book of Abstracts of the 12th International Scientific Conference on Transformation Process in Sport "Sport Performance"* (76-77), Podgorica: Montenegrin Sports Academy.
- Gardašević, J., Vasiljević, I., Bojančić, D., Muratović, A., Ljubojević, M., Milašinović, R., & Bubanja, M. (2015). Six-week Preparation Period and its Effects on Transformation Movement Speed with Soccer Players Under 16. *Book of Abstracts, International Scientific Conference "Effects of Physical Activity Application to Anthropological Status with Children, Youth and Adults"* (148), Belgrade: University of Belgrade: Faculty of Sport and Physical Education.
- Gardašević, J., Bjelica, D., & Vasiljević, I. (2016a). Six-Week Preparation Period and its Effects on Transformation Movement Speed with Soccer Players under 16. *Sport Mont*, 14(1), 13-16.
- Gardašević, J., Bjelica, D., & Vasiljević, I. (2016b). The Effects of the Training in the Preparation Period on the Repetitive Strength Transformation with Cadet Level Soccer Players. *Book of Abstracts of the 13th International Scientific Conference on Transformation Processes in Sport "Sport Performance"* (43), Podgorica: Montenegrin Sports Academy.
- Gardasevic, J., Bjelica, D., Milasinovic, R., & Vasiljevic, I. (2016). The Effects of the Training in the Preparation Period on the Repetitive Strength Transformation with Cadet Level Soccer Players. *Sport Mont*, 14(2), 31-33.
- Gardašević, J., & Vasiljević, I. (2016). Effects of Preparation Period on Endurance in U16 Soccer Players. *Book of Abstracts of the 4<sup>TH</sup> International Scientific Conference "Exercise and Quality of Life"* (108), Novi Sad: University of Novi Sad, Faculty of Sport and Physical Education.
- Gardašević, J., Bjelica, D., Popović, S., & Milašinović, R. (2016). Preparation Period and its Effects on the Speed of Ball Leading at Players U16. In *Book of Summaries of 11th FIEP European Congress "Anthropological Aspects of Sport, Physical Education and Recreation"* (30-31), Banjaluka: University of Banjaluka, Faculty of Physical Education and Sport.
- Gardasevic, J., Popovic, S., & Bjelica, D. (2016). After preparation period ball shooting accuracy at players U15. In *Abstract Book of the 8th Conference for Youth Sport* (88), Ljubljana: University of Ljubljana, Faculty of Sport.
- Gardasevic, J., Bjelica, D., & Vasiljevic, I. (2017a). The strength of kicking the ball after preparation period with U15 soccer players. *Book of Abstracts of the 14th International Scientific Conference on Transformation Processes in Sport "Sport Performance"* (65-66), Podgorica: Montenegrin Sports Academy.
- Gardasevic, J., Bjelica, D., & Vasiljevic, I. (2017b). The Strength of Kicking the Ball after Preparation Period with U15 Soccer Players. *Sport Mont*, 15(2), 39-42.
- Gardasevic, J., Bjelica, D., Popovic, S., Vasiljevic, I., & Milosevic, Z. (2018). Differences in the Anthropometric characteristics and body composition of soccer players FC Buducnost and FC Mladost in Montenegro. *Journal of Anthropology of Sport and Physical Education*, 2(1), 51-55. doi: 10.26773/jaspe.180109
- Gardasevic, J., & Bjelica, D. (2018). Preparation period and its impact on the ball control with U16 soccer players. *Kinesiologija Slovenica*, 24(3), 31-36.
- Gardasevic, J., Bjelica, D., Vasiljevic, I., Arifi, F., & Sermakhaj, S. (2019). Differences in anthropometric measures of soccerers, cup winners of Montenegro and Montenegro. *Journal of Anthropology of Sport and Physical Education*, 3(1), 23-27. doi: 10.26773/jaspe.190105
- Gardasevic, J., Bjelica, D., Vasiljevic, I., & Corluka, M. (2019). Differences in body composition of football players of two top football clubs. *Journal of Anthropology of Sport and Physical Education*, 3(4), 15-19. doi: 10.26773/jaspe.191004
- Gardasevic, J., Bjelica, D., & Vasiljevic, I. (2019a). Body composition and anthropometric measures of soccer players, champions of Bosnia and Herzegovina and Montenegro. *Book of Abstracts of the 16<sup>th</sup> Annual Scientific Conference of Montenegrin Sports Academy "Sport, Physical Activity and Health: Contemporary Perspectives"* (74-75), Podgorica: Montenegrin Sports Academy.
- Gardasevic, J., Bjelica, D., & Vasiljevic, I. (2019b). Morphological characteristics and body composition of elite soccer players in Montenegro. *International Journal of Morphology*, 37(1), 284-288.
- Gardasevic, J., & Bjelica, D. (2020). Body composition differences between football players of the three top football clubs. *International Journal of Morphology*, 38(1), 153-158.
- Gardasevic, J., Bjelica, D., & Vasiljevic, I. (2020). Differences in anthropometric characteristics between young soccer players (U19) members of the best soccer clubs in Montenegro, Bosnia and Herzegovina, and Kosovo. *Pedagogy of Physical Culture and Sports*, 24(1), 21-5.
- Green, S. (1992). Anthropometric and physiological characteristics of south Australian soccer players. *Australian Journal of Science and Medicine in Sport*, 24, 3-7.
- Gusic, M., Popovic, S., Molnar, S., Masanovic, B., & Radakovic, M. (2017). Sport-Specific Morphology Profile: Differences in Anthropometric Characteristics among Elite Soccer and Handball Players. *Sport Mont*, 15(1), 3-6.
- Masanovic, B., Corluka, M., & Milosevic, Z. (2018). Comparative Study of Anthropometric Measurement and Body Composition of Junior Soccer and Handball Players from the Serbian National League. *Kinesiologija Slovenica*, 24(3), 37-46.
- Masanovic, B., Milosevic, Z., & Corluka, M. (2018). Comparative Study of An-

- thropometric Measurement and Body Composition between Junior Handball and Volleyball Players from Serbian National League. *International Journal of Applied Exercise Physiology*, 7(4), 1-6.
- Masanovic, B. (2018). Comparative study of anthropometric measurement and body composition between junior basketball and volleyball players from Serbian national league. *Sport Mont*, 16(3), 19-24.
- Masanovic, B. (2019). Comparative Study of Morphological Characteristics and Body Composition between Different Team Players from Serbian Junior National League: Soccer, Handball, Basketball and Volleyball. *International Journal of Morphology*, 37(2), 612-619.
- Masanovic, B., Bavcevic, T., & Bavcevic, I. (2019). Comparative study of anthropometric measurement and body composition between junior soccer and volleyball players from the serbian national league. *Sport Mont*, 17(1), 9-14.
- Ramadan, J., & Byrd, R. (1987). Physical characteristics of elite soccer players. *Journal of Sports Medicine and Physical Fitness*, 27, 424-428.
- Rico-Sanz, J. (1998). Body composition and nutritional assessments in soccer. *International Journal of Sport Nutrition*, 8, 113-123.
- Sermaxhaj, S., Popovic, S., Bjelica, D., Gardasevic, J., & Arifi, F. (2017). Effect of recuperation with static stretching in isokinetic force of young soccer players. *Journal of Physical Education and Sport*, 17(3), 1948-1953. doi: 10.7752/jpes.2017.03191

**ORIGINAL SCIENTIFIC PAPER**

# Relationships Between Some Morphological Characteristics and the Body Mass Index and the Distance Achieved in Shot Put

Ahmed Abdellatif<sup>1</sup>, Badriya Al-Hadabi<sup>1</sup>

<sup>1</sup> Sultan Qaboos University, Faculty of Education, Department of Physical Education and Sports Sciences, Muscat, Oman

## Abstract

The purpose of this study was to identify the relationships between some morphological characteristics and the body mass index and the distance achieved in shot put. The sample of this study consisted of twenty-one students from Department of Physical Education at Sultan Qaboos University. Morphological characteristics namely body height, legs length, arms length, trunk length, and body weight. Body mass index was calculated as body weight in kilograms divided by height in meters squared. Distance achieved in shot put also was measured. The collected data were analyzed using the statistical package SPSS and the descriptive statistics were expressed as mean (SD) for each variable, while the simple correlation was carried out to detect the relationships between the morphological characteristics, the body mass index and the distance achieved in shot put. The analysis of the data indicates that the distance achieved in shot put was significantly correlated with body height, legs length, arms length and trunk length, while the distance achieved in shot put was not significantly correlated with body weight and body mass index.

**Keywords:** *Morphological Characteristics, Body Mass Index, Shot Put*

## Introduction

Athletics events are activities that depend on achievement of the score and the individual characteristics of the player and his ability to overcome the distance, the time and the height (Hochmuth, 1999). Morphological characteristics play a major role in superiority in the sports field, and that the skillful performance of any sport requires specific morphological characteristics (Khater & Elbeik, 1996). Many researchers confirm that the shape and structure of the body affect on many motor abilities and can improve motor performance by bringing superiority to athletes in various sports activities (Hassanein, 2000, Arifi, Bjelica, & Masanovic, 2019).

Morphological characteristics are particular importance for orientation and selection in most sports disciplines, since in the equation of the specification of almost every sport, the morphological dimensions occupy one of the most important positions.

Identifying talented children, assessing their strength and weaknesses, and planning the training programs in the proper manner are the basis of each work. Therefore, the scientists in all over the world are looking for the standard formula that can improve the performance of elite players and discover talents as precisely as possible (Popovic, Akpinar, Jaksic, Matic, & Bjelica, 2013).

Many researchers hypothesized that practicing athletes might be expected to exhibit structural and functional characteristics that are specifically favorable for their specific sport (S. Singh, K. Singh, & M. Singh, 2010). Since each sport has its own specific demands, every athlete should have specific anthropometrical characteristics and body composition figures for his own sports discipline. Tešanović et al., (2010) analyzed the relations between the body mass index and the anthropometric dimension and the results achieved in shot put. The test population encompassed 112 male

Correspondence:

**Montenegro  
Sport**

A. Abdellatif  
Sultan Qaboos University, Faculty of Education, Department of Physical Education and Sports Sciences, Al-Khoud 123, P.O. Box 31, Muscat, Sultanate of Oman  
E-mail: tifa@squ.edu.om

examinees, and they established that there was a statistically significant importance between the body mass index, anthropometric dimensions – body height and arm length and results achieved in shot put, while no statistical significance was observed in leg length.

It should be noted that the overall evaluation in the process of selecting children for the various branches of athletics should supplement, pay attention on those characteristics that may be assumed higher predictive value than top athletic results, because we cannot disregard trend of biological development, especially anthropometric characteristics. Current knowledge of theory and practice in the field of athletics suggests that when it comes to the morphological characteristics, it is necessary to pay attention to body height, body mass and the topological structure of the body, and the selection of athletic throwing should choose children with high levels of longitudinal skeleton dimensionality, the great mass of the body and a small amount of subcutaneous adipose tissue (Bošnjak, 2006).

Researchers who have studied the research in this area agree that the morphological characteristics are important determinants of success in throwing events (Milanović & Harasin, 2003; Zatciorsky, 1981). The height of the shot release affects the distance achieved, which depends on the arm length and the body height, and that the extension of the body in the moment of the throwing effectively increases the speed of release (Bastoussie, 1997)

Hence, the purpose of this study was to identify the relationships between the morphological characteristics and the body mass index on the distance achieved in shot put of the Physical education department students at Sultan Qaboos University.

## Methods

Testing was conducted on the sample of 21 male students

( $20 \pm 0.66$  yrs) from Department of Physical Education at Sultan Qaboos University who studied athletics course which includes shot put skill. Each subject who participated in testing procedures was provided with an explanation of the study and the envisaged testing procedure. All subjects needed to sign an agreement confirming that they are familiar with the purpose and objectives of the study and the testing protocol, and that they approached testing voluntary.

Morphological characteristics were measured using anthropometric measurement technique. They were measured body height, legs length, arms length, and trunk length to the nearest 0.1 cm, also body weight to the nearest 0.1 kg. Body mass index (BMI) was calculated as body weight in kilograms divided by height in meters squared ( $\text{kg}/\text{m}^2$ ). Distance achieved in shot put was measured to the nearest 0.1 cm, each student performed two attempts of shot put to the longest distance using the glide technique with (5 kg) shot, and then the best attempt was selected. All measures data were collected during the final practical exam of second semester of the academic 2017/2018 year at the sports complex for men in sultan Qaboos University with the students dressed in light clothing.

The statistical package SPSS version 22.0 (Chicago, IL, USA) was used for the statistical analysis of the collected data. The descriptive statistics were expressed as mean (SD) for each variable, while the simple correlation was carried out to detect the relationships between the morphological characteristics, the body mass index and the distance achieved in shot put.

## Results

In table 1 basic descriptive statistical parameters of (body height, legs length, arms length, trunk length, body weight), body mass index (BMI), as well as distance achieved in shot put are shown.

**Table 1.** Central and dispersion parameters of morphological characteristics, body mass index and the distance achieved in shot put ( $n = 21$ )

Variables	Minimum	Maximum	Mean	SD
Body height (cm)	158	182	170.85	5.90
Legs length (cm)	71	85	77.64	3.91
Arms length (cm)	75	90	81.83	4.02
Trunk length (cm)	83	95	89.02	3.18
Body weight (kg)	50.80	77.20	72.87	7.10
BMI	18.60	25.20	21.50	1.83
Distance achieved (m)	3.30	8.05	5.73	0.97

Note: BMI - Body mass index ; Mean – Arithmetic mean; SD – Standard deviation

In table 2 the correlations among the individual parameters are shown. The analysis of the data indicates that the distance achieved in shot put was significantly correlated with body height (0.607 at 0.01 levels), and with arms length (0.597 at 0.01 levels). That the body height was significantly correlated with body weight (0.648 at 0.01 level), with legs length (0.861 at 0.01 level), with arms length (0.822 at 0.01 level) and with trunk length (0.765 at 0.01 level). Also, the body weight was significantly correlated with BMI (0.807 at 0.01 level), with arms length (0.615 at 0.01

level), with trunk length (0.761 at 0.01 level). A significant correlation at 0.05 level is seen between legs length and arms length (0.697). Ultimately, the arms length was significantly correlated with trunk length (0.642 at 0.01 level).

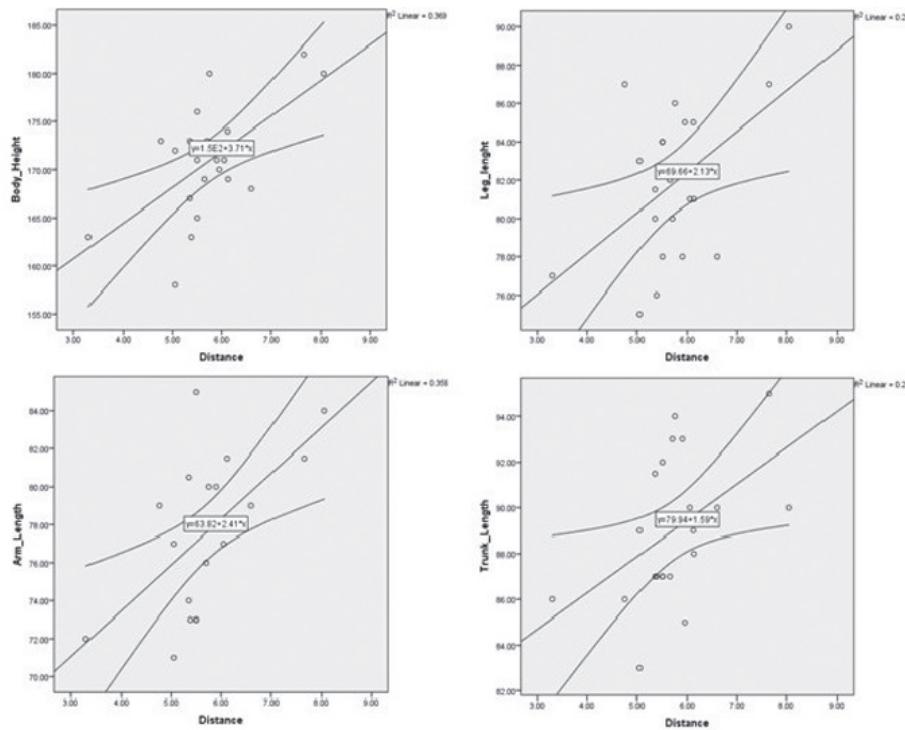
Likewise, the analysis of the data indicates that distance achieved in shot put was significantly correlated at 0.05 level with legs length (0.519) and with trunk length (0.492), while the distance achieved in shot put was not significantly correlated with body weight and with body mass index.

**Table 2.** Correlations between the morphological characteristics, the body mass index and the distance achieved in shot put

Variables	Body Height	Body weight	BMI	Legs length	Arms length	Trunk length	Distance achieved
Body Height	1						
Body weight	.648**	1					
BMI	.077	.807**	1				
Legs length	.861**	.348	-.215	1			
Arms length	.822**	.615**	.154	.697**	1		
Trunk length	.765**	.761**	.415	.331	.642**	1	
Distance achieved	.607**	.393	.038	.510*	.597**	.482*	1

Note: BMI - Body mass index ; \*\* - Correlation is significant at the 0.01 level; \* - Correlation is significant at the 0.05 level

In Figure 1 the correlations between the distance achieved in shot put and body height, legs length, arms length, trunk length is shown.



**Figure 1.** Significant correlations between the distance achieved in shot put and morphological characteristics

## Discussion

The results obtained showed that there is a significantly correlation between the distance achieved in shot put and the morphological characteristics namely body height, legs length, arms length, and trunk length, while the distance achieved in shot put was not a significantly correlated with body weight and body mass index. It was confirmed that the higher value of the player's height, arms length, legs length and trunk length, the longer the distance achieved in shot put. These results are consistent with previous research who indicates to that the morphological characteristics play a major role in superiority in the sport field, and that the skillful performance of any sport requires specific morphological characteristics (Khater & Elbeik 1996; Hassanein, 2000). Also, these results are also consistent with Bastouisse 1997, who indicates to that the height of the shot release affects the distance achieved. However, study of Tešanović et al. 2010 indicate that there was a statistically significant correlation between body height, arm length, body mass index and results achieved in shot put, while not exist a significantly correlated between the distance achieved in shot put and the legs length. The results of the current study differed with those of Tešanović et al. 2010 in terms of the relationship between the distance achieved in shot put and body mass index, and distance achieved in shot put and legs length. The researchers attributed these differences in the results to the different samples used in the two studies in terms of age and morphological characteristics.

We can conclude from previous results that the morphological characteristics play a major role in superiority in the shot put. The higher value of the player's height, arms length, legs length and trunk length, the longer higher value of the player's height, arms length, legs length and trunk length, provides the longer the distance achieved in shot put. Hence, in the selection of athletic throwing should choose children with high levels of longitudinal skeleton dimensionality.

## Acknowledgements

There are no acknowledgements.

## Conflict of Interest

The authors declare that there are no conflicts of interest.

**Received:** 5 May 2019 | **Accepted:** 7 October 2019 | **Published:** 10 January 2020

## References

- Arifi, F., Bjelica, D., & Masanovic, B. (2019). Differences in anthropometric characteristics among junior soccer and handball players. *Sport Mont*, 17(1), 45–49. doi: 10.26773/smj.190208
- Bartonietz, K., & Borgstrom, A. (1995). The throwing events at the World Championships in Athletics 1995, Geteborg: Technique of the world's best athletes. Part 1: Shot put and hammer throw. *New Studies in Athletics*, 10(4), 43–63.
- Bastouisse, A. (1997). *Track and field events, Teaching, technique and training*. Cairo: Arab thought house.
- Bošnjak, G. (2006). *Relacije antropoloških obeležja sa rezultatskom efikasnošću u bacanju kopila kod srednjoškolske omladine*. Neobjavljena doktorska disertacija. Novi Sad: Fakultet fizičke kulture.
- Hassanein, S. (2000). *Measurement and evaluation in physical education and sport*. Cairo: Arab thought house.
- Hochmuth, G. (1999). *Biomechanics and methods of scientific research of sports movements*. Cairo: Book center for publishing.
- Hubbard, M. (1988). The throwing events in track and field. In C. L Vaughan (ed.), *The Biomechanics of Sport* (pp. 213–238). Boca Raton: CRC Press.
- Khater, A., & Elbeik, A. (1996). *Measurement in the field of sport*. Alexandria: Knowledge house.
- Luhtanen, P., Blomqvist, M., & Vanttilen, T. (1997). A Comparison of two Elite Putters using the Rotational Technique. *New Studies in Athletics*, 12(4), 25–33.
- McCoy, M.W., Gregor, R.J., Whiting, W.C., Rich, R.C., & Ward, P.E. (1984). Kinematic analysis of elite shotputters. *Track Technique*, 90, 2868–2870.
- Milanović, D., & Harasin, D. (2003.). Kondicijski trening atletiara bacaa. U: D. Milanović, I. Jukić (ur.) *Uzbrniji radova meunarodnog znanstveno-stručnog skupa "Kondicijska priprema sportaša"*, Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu, Zagrebaki sportski savez.
- Popovic, S., Akpinar, S., Jaksic, D., Matic, R., & Bjelica, D. (2013). Comparative

- Study of Anthropometric Measurement and Body Composition between Elite Soccer and Basketball Players. *International Journal of Morphology*, 31(2), 461-7.
- Singh, S., Singh, K., & Singh, M. (2010). Anthropometric measurements, body composition and somatotyping of high jumpers. *Brazilian Journal of Biometrics*, 4(4), 266-271.
- Tešanović, G., Mihajlović, I., Bošnjak, G., & Dragosavljević, P. (2010) Relations between the body mass index and the anthropometric dimension and the results achieved in shot put. *Acta Kinesiologica* 4(2), 78-82.
- Tsirakos, D.K., Bartlett, R.M., & Kollias, I.A. (1995). A comparative study of the release and temporal characteristics of shot put. *Journal of Human Movement Studies*, 28, 227- 242.
- Zatciorsky, V.M. (2000). *Biomechanics in sport: Enhancement and Injury Prevention*. Oxford, UK: Blackwell Science.

**ORIGINAL SCIENTIFIC PAPER**

# Comparative Analysis of Anthropometric Parameters as Obesity Indicators for 7-8 Years-old Children of Different Resident Status

Milena Mitrović<sup>1</sup>, Katarina Dragutinović<sup>1</sup><sup>1</sup>University of Montenegro, Faculty for Sport and Physical Education, Niksic, Montenegro**Abstract**

The purpose of this study was determine obesity of 7-8 years-old children in the urban (Podgorica) and rural area (Zupa) of Montenegro and determine whether there is a statistically significant difference in obesity among them. The sample of respondents consisted of 85 children 7-8 years-old from Podgorica (urban) and Zupa Niksic (rural) divided into 4 sub-samples according to the criterium of gender and place of residence. Each respondent was calculated BMI and WHR, which were shown numerically and percentally, and the differences were determined using the t-test for small independent samples. The results of the study showed that there are statistically significant differences in overweight and obesity among children of both genders from Podgorica (urban) and Zupa (rural), where the children from Podgorica had significantly higher percentage of children from Zupa. We concluded that childrens from rural area are less obese than children in urban area. The reason for this should be found in the fact that childrens in rural area are more physically activity and healthier foods, which are the main reason for preventing obesity.

**Keywords:** *Obesity, 7-8 Years-old Childrens, Urban Area, Rural Area*

**Uvod**

Gojaznost je hronično oboljenje koje se karakteriše povećanjem masne mase tijela, u mjeri koja dovodi do narušavanja zdravlja i razvoja niza komplikacija (Branca, Nikogosian, & Loberstein, 2007; Vukušić, Filipović i Milićev, 2015). Gojaznost je medicinski problem koji je dostigao epidemijске razmjere u svijetu. Prema podacima Svjetske zdravstvene organizacije, oko 600 miliona odraslih osoba u svijetu je gojazno, a broj gojazne djece se u posljednje 3 decenije povećao za čak 300% (NCD Risk Factor Collaboration, 2017). Prevalenca gojaznosti je naročito visoka u razvijenim zemljama (Vukušić, Filipović i Milićev, 2015). Trend rasta gojaznosti je zabrinjavajući, iz razloga što gojaznost negativno utiče na zdravlje i skraćuje životni vijek.

Osnovni uzroci nastanka gojaznosti kod djece su nedovoljna fizička aktivnost i prekomerni unos hrane (Barlow, 2007; Skinner,

Mayer, Flower, & Weinberger, 2008; Dinarevic, Brankovic, & Hasanbegovic, 2011). Poznato je da djeca sve više vremena provode za računaram i ispred televizora, a sve manje u prirodi, kao i da konzumiraju brzu i nezdravu hranu i gazirane napitke, što dovodi do povećane tjelesne težine. Pretjeranim unosom nezdrave hrane i nedovoljnog fizičkom aktivnošću dolazi do disbalansa u organizmu, a rezultat toga je povećan BMI, odnosno prekomerna tjelesne težine (Freedman, Khan, Serdula, Dietz, Srinivasan, & Berenson, 2004; Jansen et al., 2008). Iz navedenog, primjećuje se da je gojaznost vrlo složen problem, koji može dovesti do niza zdravstvenih problema, kao što su poremećaj metabolizma i bolesti kardiovaskularnog sistema (Radisavljević, 2004; Vlajković i sar., 2015). Rješenje je najverovatnije u kombinovanoj terapiji. Fizička aktivnost i redukovana ishrana su sigurno vrlo moćni faktori koji mogu da pomognu većini gojaznih i prekomerno uhra-

Correspondence:

**Montenegro  
Sport**

M. Mitrović  
University of Montenegro, Faculty for Sport and Physical Education, Narodne omladine bb, 81400, Niksic, Montenegro  
E-Mail: milenam1054@gmail.com

njenih osoba da se oslobođe suvišnih kilograma (Janković, 2016).

Fizička aktivnost, ali i ishrana djece, često zavisi i od mogućnosti koje im pruža sredina u kojoj žive. S obzirom na to, mogu se javiti razlike u motoričkom i morfološkom prostoru djece. Tako, istraživanja sprovedena na ovu temu, pokazuju da se javljaju razlike u ovim prostorima između djece urbanog i ruralnog područja (Tinazci & Emiroglu, 2009; Cetinić, Petrić, i Vidaković, 2011; Vasić i sar., 2012; V. Pelešić, M. Pelešić, Mitrović, i Lalić, 2013, Tanović, Kurtaljić, Bojić, Mijatović, i Zapagić, 2013). Kako se u morfološkim karakteristikama visini tijela i masi tijela, koje se koriste za izračunavanje BMI-ja za procjenu stepena uhranjenosti, javila razlika između djece gradskog i seoskog područja, u ovom istraživanju ispitaćemo da li se javlja razlika i u indeksu tjelesne mase (BMI) i u čiju korist.

Stoga, osnovni cilj ovog istraživanja jeste izmjeriti morfološke

karakteristike djece (visina tijela, težina tijela, obim struka i obim kukova) iz Podgorice (urbano područje) i Župe Nikšić (ruralno područje) i utvrditi njihov stepen uhranjenosti. Drugi cilj jeste upoređiti dobijene rezultate, i utvrditi da li se javljaju razlike u stepenu uhranjenosti između djece urbanog i ruralnog područja. Pomoću dobijenih podataka moguće je utvrditi na kom nivou je gojaznost prisutna kod nas, kao i sprovesti odredene mjere za smanjivanje tog broja, s obzirom na njen štetan uticaj.

### Metod rada

Uzorak ispitanika činilo je 85 učenika uzrasta 7 i 8 godina osnovnih škola "Vuk Karadžić" iz Podgorice i "Dušan Bojović" iz Župe (Nikšić). Uzorak je podijeljen na 4 subuzorka, prema kriterijumima pola i mesta stanovanja (Tabela 1).

**Tabela 1.** Uzorak ispitanika

Pol/ Mjesto	Podgorica	Župa	Ukupno
Muški pol	27	17	44
Ženski pol	19	22	41
Ukupno	46	39	85

Za sve učenike pojedinačno izračunat je indeks tjelesne mase (BMI) i odnos struka i kukova (WHR). BMI je metoda za izračunavanje uhranjenosti i predstavlja težinu tijela kroz visinu tijela na kvadrat ( $\text{kg}/\text{m}^2$ ). Granične vrijednosti BMI-ja za djecu od 7 i 8 godina su: pothranjenost (<13), normalna težina (13-17), prehranjenost (17-19) i gojaznost (>19). WHR je takođe metoda za računanje uhranjenosti i predstavlja odnos struka i kukova. Granične vrijednosti WHR kod dječaka su: normalna težina (<0.94), gojaznost (0.94-1) i prekomjerna gojaznost (>1). Granične vrijednosti WHR-a kod djevojčica su: normalna težina (<0.82), gojaznost (0.82-0.9) i prekomjerna gojaznost (<0.9). Broj djece koji pripadaju određenim ka-

tegorijama uhranjenosti prema vrijednostima indeksa BMI i WHR je prikazan brojevno i procentualno. Na kraju, prikazane su srednje vrijednosti BMI-ja i WHR-a, a razlike među subuzorcima su utvrđene t-testom za male nezavisne uzorce na nivou značajnosti  $p<0.05$ .

### Rezultati

U Tabeli 2 su prizane brojevne i procentualne vrijednosti indeksa tjelesne mase po kategorijama kod svih subuzoraka. Ispitanici sa indeksom tjelesne mase manjim od 13 spadaju u pothranjene, od 13 do 17 u djecu sa normalnom težinom, od 17 do 19 u prehranjene i preko 19 u gojazne.

**Tabela 2.** Brojevni i procentualni prikaz ispitanika po kategorijama indeksa tjelesne mase (BMI)

BMI	M- Podgorica		Ž - Podgorica		M - Župa		Ž - Župa	
	N	%	N	%	N	%	N	%
Pothranjenost	0	0	0	0	0	0	2	9
Normalna težina	6	22	7	36	6	35	10	45
Prehranjenost	5	18	3	15	6	35	3	14
Gojaznost	16	60	9	48	5	30	7	32

Legenda: N - broj; % - procenat; M - muški pol; Ž - ženski pol

Na osnovu rezultata prikazanih u Tabeli 2, može se vidjeti da je broj pothranjene, odnosno neuhranjene djece veoma mali. Vrijednosti indeksa tjelesne mase ukazuju da su samo 2 djevojčice (9%) iz ruralnog područja pothranjene, dok ih kod ostalih subuzoraka nema. Normalnu težinu kod subuzoraka varira između 22% kod dječaka iz Podgorice do 45% kod djevojčica iz Župe. Normalnu težinu ima 36% djevojčica u Podgorici i 35% dječaka u Nikšiću. Procenti prehranjene djece su slični i iznose 18% kod dječaka iz Podgorice, 15% kod djevojčica iz Podgorice, 14% kod djevojčica iz Župe, dok su nešto viši kod dječaka iz Župe i iznose

35%. Procenat gojazne djece je veliki i iznosi čak 60% kod dječaka iz Podgorice, 48% kod djevojčica iz Podgorice, 30% kod dječaka iz Župe i 32% kod djevojčica iz Župe.

U Tabeli 3 su prikazane brojevne i procentualne vrijednosti odnosa struka i kukova kod svih subuzoraka. Normalnu tjelesnu težinu imaju djevojčice sa WHR vrijednostima ispod 0.82, dok gojazne djevojčice imaju WHR između 0.82 i 0.9. Pekomjerna gojaznost imaju djevojčice čiji WHR prelazi 0.9. Kod dječaka, normalna težina podrazumijeva WHR manji od 0.9. Gajazni dječaci imaju WHR između 0.9 i 1, a oni sa WHR-om preko 1 spadaju u prekomjerno gojazne.

**Tabela 3.** Brojevni i procentualni prikaz ispitanika po kategorijama indeksa odnosa struka i kukova (WHR)

WHR	M- Podgorica		Ž - Podgorica		M - Župa		Ž - Župa	
	N	%	N	%	N	%	N	%
Normalna težina	19	70	0	0	12	70	4	18
Gojaznost	7	25	9	48	5	30	11	50
Prekomjerna gojaznost	1	5	10	52	0	0	7	32

Iz Tabele 3, vidimo da veliki procenat dječaka iz Podgorice i djevojčica iz Župe imaju normalne vrijednosti odnosa struka i kukova (70%). Međutim, nijedna djevojčica iz Podgorice nema vrijednosti odnosa struka i kukova u granicama normalne težine, dok 18% dječaka iz Župe ima normalan odnos struka i kukova. Procjeni odnosa struka i kukova koji ukazuju na gojaznost kod svih subuzorka je relativno veliki i iznosi: 25% (dječaci – Podgorica), 48% (djevojčice

– Podgorica), 30% (dječaci – Župa) i 50% (djevojčice – Župa). Vrijednosti struka i kukova ukazuju da 5% dječaka iz Podgorice, 52% djevojčica iz Podgorice i 32% djevojčica iz Župe ima prekomjernu gojaznost. Nijedan dječak iz Župe nema prekomjernu gojaznost.

U Tabeli 4 prikazane su srednje vrijednosti indeksa tjelesne mase i odnosa struka i kukova kod sva 4 subuzorka. Izračunata je i standardna devijacija.

**Tabela 4.** Srednje vrijednosti indeksa tjelesne mase i odnosa struka i kukova ispitanika

<b>Uzorak</b>	<b>BMI</b>		<b>WHR</b>	
	<b>AS</b>	<b>SD</b>	<b>AS</b>	<b>SD</b>
M - Podgorica	20.21	3.95	0.89	0.03
Ž - Podgorica	18.52	3.53	0.89	0.03
M - Župa	17.65	2.53	0.87	0.03
Ž - Župa	16.83	2.99	0.86	0.05

Legenda: AS – aritmetička sredina; SD – standardna devijacija

Iz Tabele 4 primjećujemo da prosječna vrijednost indeksa tjelesne mase kod dječaka iz Podgorice iznosi  $20.21 \pm 3.95$ , dok kod djevojčica iz Podgorice iznosi  $18.52 \pm 3.53$ . Prosječna vrijednost indeksa tjelesne mase kod dječaka iz Župe iznosi  $17.65 \pm 2.53$ , a kod djevojčica iz Župe  $16.83 \pm 2.99$ . Što se tiče prosječnih vrijednosti odnosa struka i kukova, one su iste kod ispitanika oba pola

u Podgorici i iznose  $0.89 \pm 0.03$ . Srednja vrijednost odnosa struka i kukova kod dječaka iz Župe iznosi  $0.87 \pm 0.03$ , dok je kod djevojčica iz Župe nešto niža ( $0.86 \pm 0.05$ ).

U Tabeli 5 su prikazani rezultati t-testa, kojim su upoređeni rezultati indeksa tjelesne mase i odnosa struka i kukova među polovima.

**Tabela 5.** Razlika među polovima za indeks tjelesne mase i odnos struka i kukova

<b>Uzorak</b>	<b>BMI</b>		<b>WHR</b>	
	<b>t</b>	<b>Sig.</b>	<b>t</b>	<b>Sig.</b>
Dječaci	2.37	0.02	2.15	0.03
Djevojčice	1.66	0.10	2.18	0.03

Legenda: t – vrijednost t-testa; Sig. – nivo značajnosti

Na osnovu Tabele 5, zaključujemo da se među dječacima javlja statistički značajna razlika u indeksu tjelesne mase i odnosa struka i kukova, u korist dječaka iz Župe (BMI:  $t=2.37$ ,  $\text{Sig.}=0.02$ ; WHR:  $t=2.15$ ,  $\text{Sig.}=0.03$ ). Kod djevojčica, vrijednosti indeksa tjelesne mase ne pokazuju statistički značajne razlike ( $t=1.66$ ,  $\text{Sig.}=0.10$ ), dok se statistički značajne razlike javljaju kod odnosa struka i kukova ( $t=2.18$ ,  $\text{Sig.}=0.03$ ).

## Diskusija

Rezultati brojnih istraživanja ukazuju na činjenicu da je broj gojazne djece u stalnom porastu (Dinarevic, Brankovic, & Hasanbegovic, 2011). U posljednje 3 decenije, gojaznost je u pojedinim zemljama porasla od 2 do 5 puta (Flynn, McNeil, Maloff, Mutasingwa, Wu, Ford, & Tough, 2006). Posmatrajući rezultate ovog istraživanja, možemo konstatovati slično – vrijednosti indeksa tjelesne mase i odnosa struka i kukova pokazuju da je veliki procenat izmjerene djece gojazan ili prekomjerno gojazan. Izužetno visoki procenti indeksa tjelesne mase, od čak 60% kod dječaka iz Podgorice i 40% kod djevojčica iz Podgorice, kao 30%, odnosno 32% kod dječaka i djevojčica iz Župe, su izuzetno zabrinjavajući, s obzirom na uticaj gojaznosti na zdravlje djece i odraslih (Dinarevic, Brankovic, & Hasanbegovic, 2011). Takođe, relativno visok je i procenat djece sa prekomjernom težinom koja vode do gojaznosti. Da je gojaznost kod ove djece prisutna na visokom nivou, govori i činjenica da je procenat indeksa tjelesne mase u područjima mediteranskih zemalja od 20% do 40%, dok je u Sjevernoj Evropi još manji i iznosi od 10% do 20% (Banićević i Zdravković, 2008). Upoređujući ove rezultate sa rezultatima dobij-

jenim u našem istraživanju, primjetićemo da je BMI kod kod nas viši i do čak 40%. Ukoliko rezultate uporedimo sa rezultatima djece iz regionala, razlike u BMI-ju su još i visočije, skoro 50% (Bukara Radujković i Zdravković, 2008; Kisić Tepavčević, Jovanović, Kisić, Nalić, Repčić, Popović i Pekmezović, 2008; Despotović, Alekso-pulos, Despotović i Ilić, 2013).

Rezultati dobijeni ovim istraživanjem pokazuju da je situacija u kojoj se našla naša omladina vrlo zabrinjavajuća, jer je gojaznost faktor rizika nastanka mnogih hroničnih oboljenja, najčešće krvnog i srčanog sistema (Haslam, James, & Philip, 2005). U prilog tome ide i činjenica da Svjetska zdravstvena organizacija predviđa da će gojaznost uskoro biti najvažniji uzrok lošeg zdravlja (Fauci, Kasper, Longo, Braunwald, Hauser, Jameson, & Loscalzo, 2008). Razlog ovim rezultatima možemo tražiti u činjenici da se djeca sve više hrane brzom, nezdravom hranom, provode više vremena na računaru i ispred televizora, a sve manje se bave fizičkim aktivnostima (Dollman, K. Norton, & L. Norton, 2005; Dinarevic, Brankovic, & Hasanbegovic, 2011; Mitrović, & Dragutinovic, 2019).

Nedavno sprovedena istraživanja pokazala su da su osobe oba pola iz ruralnih sredina gojazniji od osoba iz urbane sredine (NCD Risk Factor Collaboration, 2019). Kao razlog tome, navode se sve bolje uslovi na selu, koji su doveli do brojnih zdravstvenih koristi, ali i do manje potrošnje energije i prekomjernog unosa hrane. Međutim, u našem istraživanju, rezultati pokazuju suprotno, dječaci iz urbanog područja su gojazniji od djece iz ruralnog područja. Vrijednosti BMI-ja ukazuju da su te razlike statistički značajne kod dječaka, a vrijednosti WHR-a ukazuju na statističku značajnost kod oba pola. Razlozi za dobijene razlike mogu biti

različiti, a djelimično se mogu opravdati činjenicom da se djeca u ruralnoj sredini zdravije hrane i više bave fizičkim aktivnostima od djece u urbanoj sredini (Paklarčić, Kukić, Karakaš, Osman i Kerić, 2013).

Na kraju, možemo zaključiti, da je utvrđen je stepen uhrajanosti djece urbanog i ruralnog područja, kao i razlike među njima. Međutim, ono što predstavlja zabrinjavajuću činjenicu jesu visoki procenti prekomjerno uhranjene i gojazne djece, i u urbanoj i u ruralnoj sredini. S obzirom da se radi o malom uzorku, potrebljeno je dalje sprovoditi ovakva istraživanja, kako bi se dobili pouzdaniji podaci. Svakako, rezultati istraživanja ukazuju da više pažnje treba posvetiti prevenciji gojaznosti, upućivanju djece na rizike gojaznosti, pravilnu i zdravu ishranu, kao i važnost bavljenja fizičkim aktivnostima (Mitić, 2011; Bjelica i Petković, 2009; Bjelica i Krivokapić, 2010; Bjelica i Krivokapić, 2011a, Bjelica i Krivokapić, 2011b; Bjelica i Krivokapić, 2019).

#### Acknowledgements

There are no acknowledgements.

#### Conflict of Interest

The authors declare that there are no conflicts of interest.

**Received:** 16 May 2019 | **Accepted:** 30 July 2019 | **Published:** 10 January 2020

#### References

- Banićević, M., i Zdravković, D. (2008). *Sprečimo gojaznost i sačuvajmo zdravlje dece i adolescenata*. Beograd: Udrženje pedijatara Srbije.
- Barlow, S.E. (2007). Recommendations Regarding the Prevention, Assessment and Treatment of Child and Adolescent Overweight and Obesity: Summary Report. *Pediatrics*, 120, 164-192.
- Bjelica, D., i Krivokapić, D. (2019). *Teorija sporta i tjelesnog vježbanja*. Nikšić: Fakultet za sport i fizičko vaspitanje, Podgorica: Crnogorska sportska akademija.
- Bjelica, D., i Krivokapić, D. (2010). *Teorijske osnove fizičke kulture*. Podgorica: Crnogorska sportska akademija.
- Bjelica, D., i Krivokapić, D. (2011a). *Teorija igre*. Nikšić: Fakultet za sport i fizičko vaspitanje, Podgorica: Crnogorska sportska akademija.
- Bjelica, D., i Krivokapić, D. (2011b). Zdravstveno-preventivna uloga tjelesne aktivnosti omladine. U *Zborniku radova VI Međunarodne konferencije "Menadžment u sportu"* (144-149). Beograd: Alfa univerzitet, Fakultet za menadžment u sportu, Olimpijski komitet Srbije.
- Bjelica, D., i Petković, J. (2009). *Teorija fizičkog vaspitanja i osnove školskog sporta*. Podgorica: Crnogorska sportska akademija, Nikšić: Fakultet za sport i fizičko vaspitanje.
- Branca, F., Nikogosian, H., & Lobstein, T. (2007). *The challenge of obesity in the WHO European Region and the strategies for response*. Geneva: World Health Organisation.
- Bukara Radujković, G., i Zdravković, D. (2009). Fizička aktivnost značajan faktor u sprečavanju gojaznosti u dečjem uzrastu. *Medičinski Pregled*, 3-4, 107-113.
- Cetinić, J., Petrić, V., i Vidaković, D. (2011). Urbano ruralne razlike antropometrijskih obilježja, motoričkih i funkcionalnih sposobnosti te motoričkih dostignuća učenika rane školske dobi. U *Zborniku radova 20. Ljetne škole kinezioologa republike Hrvatske* (233-238). Zagreb: Hrvatska kinezološka asocijacija.
- Despotović, M., Aleksopoulos, H., Despotović, M., i Ilić, B. (2013). Stanje uhrajanjenosti dece predškolskog uzrasta, *Medičinski Časopis*, 47(2), 62-68.
- Dinarević, S., Branković, S., & Hasanbegović, S. (2011). Relation of diet and physical activity to obesity in children in elementary schools. *Journal of Health Sciences*, 1(1), 44-49.
- Dollman, J., Norton, K., & Norton, L. (2005). Evidence for secular trends in children's physical activity behaviour. *British Journal of Sports Medicine*, 39(12), 892-897.
- Fauci, A., Kasper, E., Longo, D., Braunwald, S., Hauser, D., Jameson, L., & Loscalzo, J. (2008). *Harrison's Principles of Internal Medicine*, 17th Edition. *Internacional Medicine Journal*, 38(12), 932-942.
- Flynn, M.A., McNeil, D.A., Maloff, B., Mutasingwa, D., Wu, M., Ford, C., & Tough, S.C. (2006). Reducing obesity and related chronic disease risk in children and youth: a synthesis of evidence with 'best practice' recommendations. *Obesity Reviews*, 1(7), 66.
- Freedman, D.S., Khan, L.K., Serdula, M.K., Dietz, W.H., Srinivasan, S.R., & Berenson, G.S. (2004). Inter-relationships among childhood BMI, childhood height, and adult obesity: the Bogalusa Heart Study. *International Journal of Obesity*, 28(1), 10-16.
- Haslam, D.W., James, W., & Philip, T. (2005) Obesity. *Lancet*, 366(9492), 1197-209.
- Janković, G. (2016). *Prevalenca gojaznosti učenika prvog i drugog razreda osnovne škole iz gradske i seoske sredine*. Neobjavljeni master rad, Beograd: Fakultet sporta i fizičkog vaspitanja.
- Jansen, W., Raat, H., Zwanenburg, E.J., Reeuvers, I., Van Walsem, R., & Brug, J. (2008). A school-based intervention to reduce overweight and inactivity in children aged 6-12 years: study design of a randomized controlled trial. *BMC Public Health*, 25(8), 257.
- Kisić Tepavčević, D., Jovanović, N., Kisić, N., Nalić, D., Repčić, M., Popović, A., i Pekmezović, T. (2008). Prevalencija gojaznosti u uzorku dece školskog uzrasta u Beogradu. *Srpski arhiv za celokupno lekarstvo*, 136(11,12), 621-624.
- Mitić, D. (2011). Značaj fizičke aktivnosti u prevenciji i terapiji gojaznosti u detinjstvu i adolescenciji. *Medičinski glasnik*, 107-112.
- Mitrović, M., & Dragutinovic, K. (2019). Comparative Analysis of Anthropometric Parameters as Obesity Indicators for Seven-year-old Children of Different Resident Status. In *BMC Sports Science, Medicine and Rehabilitation Supplement of 5th International Scientific Conference on Exercise and Quality of Life*, 11(P96, Suppl. 1), 38, Novi Sad: Faculty of Sport and Physical Education, University of Novi Sad; doi: 10.1186/s13102-019-0119-7.
- NCD Risk Factor Collaboration (2017). Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128.9 million children, adolescents, and adults. *Lancet*, 390(10113), 2627-2642.
- NCD Risk Factor Collaboration (2019). Rising rural body-mass index is the main driver of the global obesity epidemic in adults. *Nature*, 569, 260-264.
- Paklarčić, M., Kukić, E., Karakaš, S., Osman, Z., i Kerić, E. (2013). Prehrana i razlike u prehrani školske djece u urbanoj i ruralnoj sredini na području općine Travnik. *HRANA U ZDRAVLJU I BOLESTI, ZNANSTVENO-STRUČNI ČASOPIS ZA NUTRICIONIZAM I DIJETETIKU*, 2(2), 50-57.
- Pelemiš, V., Pelemiš, M., Mitrović, N., i Lalić, D. (2013). Kvantitativne analize razlike motoričkog prostora djece urbane i ruralne sredine. *Nova škola*, 11, 118-130.
- Radisavljević, N. (2004). Gojaznost – nova saznanja. *Opšta medicina*, 10(3,4), 143-147.
- Skinner, A. C., Mayer, M. L., Flower, K., & Weinberger, M. (2008). Health Status and Health Care Expenditures in a Nationally Representative Sample: How Do Overweight and Healthy-Weight Children Compare? *Pediatrics*, 121(2), e269-e277. doi:10.1542/peds.2007-0874
- Tanović, I., Kurtalisa, A., Bojić, A., Mijatović, V., i Azapagić, E. (2013). Razlike u motoričkim sposobnostima učenika VI-VIII razreda osnovne škole urbanog i ruralnog područja Brčko distrikta. U *Zborniku radova Treće međunarodne konferencije Sportske nauke i zdravlje* (450-455). Banja Luka: Panevropski univerzitet APEIRON.
- Tinazzi, C., & Emiroglu, O. (2009). Physical Fitness of Rural Children Compared with Urban Children in North Cyprus: A Normative Study. *Journal of Physical Activity and Health*, 6, 88-92.
- Vasić, Z., Vidović, S., Vulić, I., Šnjegota, D., Šuščević, D., Bojić, N., i Baroš, I. (2012). Komparativna analiza antropometrijskih parametara učenika osnovnih škola urbanog i ruralnog područja regije Doboj. *Glasnik Antropološkog društva Srbije*, 47, 163-72.
- Vlajković, V., Macanović, G., Arsić, J., Jocić, I., Milovanović, D., i Arsić, D. (2015). Gojaznost kod školske dece kao faktor rizika po zdravlje. *PONS Med Journal*, 9-14.
- Vukušić, K., Filipović, D., i Milićev, S. (2015). Gojaznost. *Sport – nauka i praksa*, 5(1-2), 77-87.

**ORIGINAL SCIENTIFIC PAPER**

# Analysis of Obesity and Differences in Nutritional Status of School Children in Central and Southern Region of Montenegro

Dragan Bacovic<sup>1</sup><sup>1</sup>University of Montenegro, Faculty for Sport and Physical Education, Niksic, Montenegro**Abstract**

The aim of this research was to determine obesity and differences in nutritional status of school children in Central and Southern region in Montenegro. The research involved 189 children divided into two sub-samples: 84 children (7-8 years) from Central region and 105 children (7-8) years from Southern region of Montenegro. Anthropometrics characteristics were evaluated by a battery of 3 variables: body height, body weight, waist circumference. Mentioned variables were used to calculate following anthropometric indexes which gave as informations about obesity: body mass index (BMI), waist to height ratio (WHtR). The difference between the children are tested by a t-test for small independent samples. It's determined that there are no significant differences between children in Central and Southern region of Montenegro in any monitored variables. Also, it was found that 16.4 % of children were obese and those results can help us to apprehend problem of excessive body weight at specified age and find adequate solutions for this problem.

**Keywords:** Children, Body Mass Index, Waist to Height Ratio, Montenegro

**Uvod**

Aktuelan način života, prouzrokovao je i tehnološkom revolucijom, doveo je do toga da je broj djece koja imaju povećanu tjelesnu masu u stalnoj progresiji. Prekomjerna tjelesna masa u periodu mlađeg školskog uzrasta predstavlja prediktor gojaznosti u kasnijem životu, te je stoga potrebno djelovati što ranije kako bi se ta negativna pojava neutralizovala. Dijete formira svoje navike pod uticajem socijalne sredine, kao i raspoloživih mogućnosti. Loše prehrambene navike (velika količina i neadekvatan kvalitet) mogu da dovedu do mnogih nutritivnih devijacija što u sprezi sa hipokinezijom dovodi do katastrofalnih posledica za organizam djeteta. Gajaznost je jedan od vodećih zdravstvenih problema sa kojim se savremeno društvo susreće (Thun, Apicella, & Henley, 2000), a nastaje kao rezultat neravnoteže energetskog unosa i potrošnje (Bukara – Radujković, & Zdravković, 2009). Ukoliko je gojaznost prisutna u ranom djetinjstvu, postoji tendencija da

dijete ima problem sa gojaznošću i tokom daljeg odrastanja, sa rizikom od ranog obolijevanja od hronično nezaraznih bolesti, kao što su dijabetes, povišen krvni pritisak i koronarna arterijska bolest (Lobsten, Baur, & Uauy, 2004; De Onis i sar., 2010; Popović, Bjelica, Mašanović, & Vukotić, 2018). U istraživanjima koja su sprovedena u regionu pokazano je da svako treće dijete provodi od tri do pet sati dnevno ispred kompjutera ili televizora što umnogome utiče na povećanje tjelesne mase (Despotović, Alekhopulos, Despotović, & Ilić, 2014). Takođe, brojne studije u Sjevernoj Americi i Evropi su pokazale da je povećana tjelesna masa u djetinjstvu i mladosti povezana sa većim rizikom za oboljenja u kasnijem životu (Koletti, 2010; Mekhora, 2010).

Prema zvaničnim podacima Međunarodne radne grupe za gojaznost (IOTF) i Svjetske zdravstvene organizacije (WHO), oko 2,1 milijardi ljudi ima problem prekomjerne tjelesne mase, od to-

Correspondence:

**Montenegro Sport**

D. Bacovic  
 University of Montenegro, Faculty for Sport and Physical Education, Narodne omladine bb, 81400, Niksic, Montenegro  
 E-Mail: dragibacovic1@gmail.com

ga broja 160 miliona su djece, od koji je 22 miliona mlađe od pet godina (World Health Organization, 2004). Epidemija gojaznosti manifestuje se više u zapadnim zemljama, gdje brojke pokazuju da se u poslednjih dvadeset godina broj onih sa prekomjernom tjelesnom težinom povećao za tri puta. Procjenjuje se da je samo u Sjedinjenim Američkim Državama svako četvrti dijete gojazno (Nicklas, Baranowski, Cullen, & Berenson, 2001). Svjetska zdravstvena organizacija (WHO) je 2004. godine usvojila globalnu strategiju o ishrani, fizičkoj aktivnosti i zdravlju čiji je primarni cilj unapređenje zdravlja pravilnom ishranom i fizičkom aktivnošću. Za uspješno ostvarenje ovog cilja neophodno je da nacionalni programi obuhvate djecu i mlade, a institucije namjenjene ovoj populaciji su posebno značajne u formiranju navika koje doprinose očuvanju i unapređenju zdravlja, poput pravilne ishrane, promocije fizičke aktivnosti, ili ograničavanja vremena provedenog uz ekrane. Praćenje antropometrijskih promjena u populaciji može biti ključno u sprečavanju budućih problema javnog zdravlja, kao što je gojaznost (Popović, Bjelica, Vukotić, & Mašanović, 2018; Mašanović, Vukotić, Bjelica, & Popović, 2018). Istraživanja ovog tipa teže da pomognu u objašnjavanju veoma bitnih uloga obrazovanja, fizičke aktivnosti i pravilne ishrane mladih u prevenciji negativnih zdravstvenih ishoda povezanih sa gojaznošću.

U ovom istraživanju postavljena su dva cilja. Prvi se odnosi na ispitivanje gojaznosti kod učenika koji pohađaju drugi i treći razred osnovne škole u Centralnoj i Južnoj regiji Crne Gore. Drugi cilj se odnosi na utvrđivanje razlika u uhranjenosti među navedenim uzorkom. Na osnovu navedenog, jasno se može zaključiti da je gojaznost itekako prisutna u cijelom svijetu, pa samim tim bi se trebalo osvrnuti i na našu zemlju, kao zemlju u razvoju, i napraviti presjek stanja na određenom uzorku ispitanika, u ovom slučaju djece uzrasta 7 i 8 godina, koja žive u Centralnom i Južnom regionu Crne Gore. Nakon sprovedenog istraživanja dobiće se korisni podaci koji će pokazati kakvo je stanje uhranjenosti učenika drugog i trećeg razreda Osnovnih škola u Centralnoj i Južnoj regiji Crne Gore, da li pripadaju rizičnoj grupi, kao i da li se učenici Centralne i Južne regije razlikuju u stepenu uhranjenosti. Na osnovu ovih podataka biće moguće, ukoliko je to potrebno, pokrenuti aktivnosti u pravcu prevencije ili korekcije.

## Metod

U pogledu vremenske određenosti istraživanje je transverzalnog karaktera, a sastoji se u jednokratnom mjerenu odgovarajućih antropometrijskih karakteristika djece uzrasta 7-8 godina koji žive i pohađaju osnovnu školu u Centralnoj (Nikšić) i Južnoj (Herceg Novi) regiji Crne Gore. Ukupan broj ispitanika

ka je 189. Svi ispitanici su podijeljeni na dva subuzorka. Prvi subuzorak je činilo 84 učenika Osnovne škole "Mileva Lajović Lalatović" iz Nikšića, dok je drugi subuzorak činilo 105 učenika Osnovne škole "Milan Vuković" iz Herceg Novog. Antropometrijsko mjerjenje je sprovedeno uz poštovanje osnovnih pravila i principa vezanih za izbor mjernih instrumenata i tehnike mjerjenja koje preporučuje Internacionalni Biološki Program. Za potrebe ovog istraživanja izmjerene su sledeće antropometrijske varijable: tjelesna visina, tjelesna masa i obim struka. Pomenute antropometrijske mjere upotrebljene su kako bi bili određeni: indeks tjelesne mase (BMI) i odnos struka i tjelesne visine (WHtR) koji su korišćeni za procjenu stanja uhranjenosti. BMI svakog djeteta je izračunat tako što se tjelesna težina podijelila sa kvadratom visine, a nakon toga upoređen sa referentnim vrijednostima za uzrast i pol. Indeks tjelesne mase (BMI) za djecu i mlade osobe se izračunava u zavisnosti od starosti i pola, što je veoma specifično zbog njihovog rasta i razvoja (Vasiljević, Bjelica, Popović, & Gardašević, 2015). Prilikom procjene uhranjenosti, smatralo se da je učenik/ca u kategoriji ispod normalne uhranjenosti ukoliko su vrijednosti iznosile ispod 5 percentila, normalne uhranjenosti ukoliko su vrijednosti iznosile od 5 do 85 percentila, dok su u kategoriji za prekomjernu težinu uračunati oni kojima je BMI iznosio za njihov uzrast i pol  $>85$ , a  $\leq 95$  percentila, na kraju gojaznost je ustanovljena ukoliko je vrijednost prelazila 95. percentil. Odnos struka i visine (WHtR) za djecu je značajan indikator gojaznosti, naročito dobar indikator za procjenu zdravstvenog rizika, a izračunava se tako što se vrijednost obima struka podijeli sa vrijednostima tjelesne visine. Dijete se smatralo gojaznim ukoliko je WHtR iznosio više od 0.5 (McCarthy, & Ashwell, 2006).

Svi podaci potrebni za ovo istraživanje obrađeni su u specijalizovanom programu za obradu podataka SPSS statistics 23.0 (Chicago, IL, USA). Podaci su obrađeni postupcima deskriptivne i komparativne statističke procedure. Razlike u indeksima za procjenu uhranjenosti, odnosno gojaznosti učenika uzrasta 7 i 8 godina iz Centralne i Južne regije utvrđene su primjenom t-testa za male nezavisne uzorke, sa statističkom značajnošću od  $p<0.05$ .

## Rezultati

U Tabeli 1 prikazana je klasifikacija ispitanika u kategorije kojima pripadaju prema vrijednosti indeksa tjelesne mase (BMI) izražem u percentilima, dok su u Tabeli 2 prikazani centralni i disperzionalni parametri varijabli indeks tjelesne mase (BMI) i odnos struka i tjelesne visine (WHtR) učenika Centralne i Južne regije Crne Gore.

**Tabela 1.** Klasifikacija ispitanika u kategorije prema vrijednosti indeksa tjelesne mase (BMI) izražem u percentilima

BMI	Kategorija	Centralna regija		Južna regija		Total	
		N	%	N	%	N	%
Percentile							
<5(<13.6kg/m <sup>2</sup> )	Pothranjenost	6	3.17	4	2.11	10	5.28
5-85(13.6-17.3kg/m <sup>2</sup> )	Normalna uhranjenost	51	27.00	60	31.74	111	58.74
85-95(17.3-18.5kg/m <sup>2</sup> )	Prekomjerna uhranjenost	13	6.88	24	12.70	37	19.58
>95(>18.5kg/m <sup>2</sup> )	Gojaznost	14	7.40	17	9.00	31	16.40
Total		84	44.45	105	55.55	189	100

Legenda: BMI - Indeks tjelesne mase; N - broj ispitanika; % - procenat

U Tabeli 1 dat je prikaz prosječnih vrijednosti indeksa tjelesne mase (BMI) učenika osnovnih škola u odnosu na region u kojem žive. Na osnovu vrijednosti indeksa tjelesne mase (BMI) sa povиšenom tjelesnom masom ( $17.3-18.5 \text{ kg/m}^2$ ) bilo je ukupno 37 ispitanika (19.58%), od toga 13 ispitanika (6.88%) pripa-

da Centralnoj regiji Crne Gore, a 24 ispitanika (12.7%) pripada Južnoj regiji. Takođe se može primijetiti da je 31 ispitanik bio gojazan ( $>18.5 \text{ kg/m}^2$ ) što je 16.4 %, od čega je 14 (7.4%) ispitanika pripadalo Centralnoj regiji, a 17 ispitanika (9.0%) Južnoj regiji Crne Gore.

**Tabela 2.** Prikaz prosječnih vrijednosti indeksa tjelesne mase (BMI) i indeksa odnos struka i tjelesne visine (WHtR) učenika Centralne i Južne regije Crne Gore

	<b>City</b>	<b>N</b>	<b>Mean</b>
Indeks tjelesne mase (BMI)	Centralna regija	89	16.81
	Južna regija	105	17.64
Indeks odnosa struka i visine (WHtR)	Centralna regija	89	.47
	Južna regija	105	.47

Legenda: City - grad N – broj ispitanika; Mean - aritmetička sredina

Na osnovu vrijednosti indeksa tjelesne mase (BMI), što je prikazano u Tabeli 2, može se konstatovati da učenici Južne regije imaju veće numeričke vrijednosti od učenika Centralne regije, da li i statistički značajne pokazaće rezultati t-testa. Takođe na osnovu ove vrijednosti može se vidjeti da učenici Južne regije u prosjeku pripadaju kategoriji prekomjerne uhranjenosti, dok učenici Centralne regije u prosjeku pripadaju kategoriji normalne uhranjenosti. Na osnovu

vrijednosti indeksa odnos struka i tjelesne visine (WHtR) može se konstatovati da nema razlika u numeričkim vrijednostima između učenika Centralne i Južne regije Crne Gore. Kada se pogleda ova varijabla može se primjetiti da se učenici obje regije nalaze ispod granice koja označava prekomjernu uhranjenost (<0.5 percentila). Na osnovu varijable WHtR može se konstatovati da se učenici uključeni u ovo istraživanje nalaze na gornjoj granici normalne uhranjenosti.

**Tabela 3.** Razlike u uhranjenosti između učenika drugog i trećeg razreda Centralne i Južne regije Crne Gore

	<b>City</b>	<b>N</b>	<b>Mean</b>	<b>t-test</b>	<b>Sig.</b>
Indeks tjelesne mase (BMI)	Centralna regija	84	16.81	-1.212	.227
	Južna regija	105	17.64		
Indeks odnosa struka i visine (WHtR)	Centralna regija	84	.47	.024	.981
	Južna regija	105	.47		

Legenda: City - grad; N – broj ispitanika; Mean – aritmetička sredina; Sig. – značajnost razlike

Na osnovu dobijenih rezultata t-testa, koje su prikazane u Tabeli 3, može se primjetiti da ne postoje statistički značajne razlike u stepenu uhranjenosti između učenika drugog i trećeg razreda Centralne i Južne regije Crne Gore na nivou značajnosti od  $p<0.05$ . Uvidom u numeričke vrijednosti testiranih varijabli može se konstatovati da učenici koji pripadaju Južnoj regiji imaju veće numeričke vrijednosti indeksa tjelesne mase (BMI) ali ne i statistički značajne, dok vrijednosti indeksa odnos struka i tjelesne visine (WHtR) ukazuju da razlika ne postoji.

koji pripadaju Centralnoj i Južnoj regiji ima identičnu vrijednost od 0,47 i pokazuje da učenici Centralne i Južne regije Crne Gore ne pripadaju grupi normalno uhranjene djece, da se nalaze na gornjoj granici normalne uhranjenosti (<0,5), te da među njima ne postoji razlika, što je takođe u skladu sa predhodnim studijama (Malovic, 2019). Na osnovu toga može se zaključiti da ne postoje regionalne razlike u tepenu uhranjenosti između djece koja pripadaju Srednjoj i Južnoj regiji Crne Gore.

S obzirom pa je indeks tjelesne mase (BMI) ipak pokazao visok procenat prekomjerno uhranjene i gojazne djece, u budućnosti su neophodne i preventivne mjere, a takođe i intervencije vezane za redukciju tjelesne mase određenog procenta djece. Takođe je potrebna adekvatna edukacija svih članova porodice gojazne djece radi promena u načinu života (usvajanje trajnih izmjena u načinu ishrane i fizičkoj aktivnosti), kako bi se postigla trajna promjena energetske ravnoteže.

Ograničenje, odnosno limitiranost ove studije može biti sami uzorak, koji nije dovoljno veliki u odnosu na cijelokupnu populaciju. Dakle, u studijama sličnog karaktera trebalo bi uključiti djece Sjeverne regije, kao i djecu iz ruralnih i polururalnih područja, na taj način bi sigurno dobili preciznije podatke za postavljeno istraživačko pitanje. Sigurno da navedena konstatacija, ne umanjuje doprinos ove studije, jer su u njoj iznešeni određeni zaključci koji mogu poslužiti kao dobar putokaz za istraživanja koja će se baviti sličnom problematikom na još većem uzorku ispitanika. Kao preporuka za buduća istraživanja koja će se baviti ovom problematikom bi mogla biti da se testira i nivo uhranjenosti roditelja djece, jer se u literaturi mogu pronaći podaci koji ukazuju da je uhranjenost roditelja u visokoj korelaciji sa uhranjenosti djece (Bukara-Radujković i Zdravković, 2008). Od velikog značaja bi bilo to potvrditi i na uzorku crnogorske populacije, i na taj način skrenuti pažnju roditeljima da oni u većini slučajeva imaju najveću odgovornost za stanje uhranjenosti njihove djece. Takođe, da bi se moglo uticati da se trend gojaznosti smanji ili spriječi neophodno je da se svijest cijelokupnog društva o fizičkom vježbanju i kvalitetnoj ishrani školske djece podigne na viši nivo (Mitrovic, Pelemis, & Pelemis, 2014).

## Diskusija

Rezultati ispitivanja pokazuju da povisenu tjelesnu masu imaju 37 ispitanika (19.58%), dok je 31 ispitanik (16.4%) bio gojazan. Rezultati u studiji koju je sproveo Malovic (2019) na uzorku djece uzrasta 7 i 8 godina, koja pripadaju Centralnoj (Nikšić) i Južnoj (Kotor) regiji Crne Gore, pokazuju skoro identičan procenat gojaznih učenika (16.3%). U studiji koju su sproveli Obradovic i Srdic (2007) na uzorku od 490 djece iz Srbije, uzrasta 8-11 godina utvrđeno je da se gojaznost djece mlađeg školskog uzrasta kreće između 11.6% i 22.0%. Navedene studije su u skladu sa rezultatima ovog istraživanja i pokazuju da je značajan broj djece mlađeg školskog uzrasta prekomjerno uhranjeno ili gojazno. Da bi se utvrdilo da li postoji regionalna razlika kada je u pitanju uhranjenost, s obzirom da navike u ishrani i način života osoba koje žive na različitim području mogu biti drugačiji, sprovedena je procjena stanja uhranjenosti djece koja pripadaju Centralnoj i Južnoj regiji Crne Gore. Utvrđeno je da ne postoje statistički značajne regionalne razlike u stepenu uhranjenosti između djece koja pripadaju Centralnoj i Južnoj regiji Crne Gore. Za procjenu uhranjenosti djece upotrebljena su dva antropometrijska indeksa: Indeks tjelesne mase (BMI) i odnos struka i tjelesne visine (WHtR). Sto se tiče indeksa tjelesne mase, izračunate su percentilne vrijednosti za svakog ispitanika posebno, na osnovu čega je dobijen ranije navedeni procenat prekomjerno uhranjene i gojazne djece. Takođe, izračunata je prosječna vrijednost indeksa tjelesne mase (BMI) obje grupe ispitanika kako bi se ispitale razlike u stepenu uhranjenosti među njima. Indeks odnosa struka i tjelesne visine (WHtR) kod učenika

**Acknowledgements**

There are no acknowledgements.

**Conflict of Interest**

The authors declare that there are no conflicts of interest.

**Received:** 28 May 2019 | **Accepted:** 11 September 2019 | **Published:** 10 January 2020

**References**

- Bukara-Radujkovic, G., i Zdravkovic, D. (2009). Fizička aktivnost značajan faktor u sprečavanju gojaznosti u dječjem uzrastu. *Medicinski pregled*, 62(3-4), 107-113.
- De Onis, M., Blossner, M., & Borghi, E. (2010). Global prevalence and trends of overweight and obesity among preschool children. *The American Journal of Clinical Nutrition*, 92, 1257-1264.
- Dennison, B. A. M., Erb, T. A., & Jenkins, P. L. (2002). Television viewing and television in bedroom associated with overweight risk among low-income preschool children. *Pediatrics*, 109(6), 1028-1035.
- Despotovic, M., Alekhopulos, H., Despotovic, M., & Ilic, B. (2014). Stanje uhranjenosti dece predškolskog uzrasta. *Medicinski časopis*, 47(2), 62-68.
- Krassas, G. E., Tzotzas, T., Tsametis, C., & Konstantinidis, T. (2001). Prevalence and trends in overweight and obesity among children and adolescents in Thessaloniki, Greece. *Journal of Pediatric endocrinology & Metabolism*, 14(5), 1319-1326.
- Lobstein, T., Baun, L., & Uauy, R. (2004). IASO International Obesity Task Force. Obesity in children and young people: a crisis in public health. *Obesity Reviews*, 5(1), 4-85.
- Malovic, P. (2019). Anthropometric Indices as Indicators of Obesity of Children from Elementary School in Montenegro. *Journal of Anthropology of Sport and Physical Education*, 3(2), 43-47.
- Masanovic, B., Vukotic, M., Bjelica, D., & Popovic, S. (2018). Describing Physical Activity Profile of Older Montenegrin Males Using the International Physical Activity Questionnaire (IPAQ). In *Book of Abstracts 15th International Scientific Conference of Transformation Process in Sport "Sport Performance"* (60-61). Podgorica: Montenegrin Sports Academy.
- Vasiljevic, I., Bjelica, D., Popovic, S., & Gardasevic, J. (2015). Analysis of nutrition of preschool-age and younger school-age boys and girls. *Journal of Physical Education and Sport*, 15(3), 426-28.
- Thun, M. J., Apicella, L. F., & Henley, S. J. (2000). Smoking vs other risk factors as the cause of smoking-attributable deaths: confounding in the courtroom room. *Journal of the American Medical Association*, 284(6), 706-712.
- World Health Organization (2004). *World health report*. Geneva: World Health Organization.
- International Scientific Conference of Transformation Process in Sport "Sport Performance" (61). Podgorica: Montenegrin Sports Academy.
- McCarthy, H. D., & Ashwell, M. (2006). A study of central fatness using waist-to-height ratios in UK children and adolescents over two decades supports the simple message – “keep your waist circumference to less than half your height”. *International Journal of Obesity*, 30, 988-92.
- Mendoza, J. A., Zimmerman, F. J., & Shristakis, D. A. (2007). Television viewing, computer use, obesity and adiposity in USA preschool children. *International Journal of Behavioral Nutrition and Physical Activity*, 4(1), 44.
- Mitrovic, N., Pelemis, M., & Pelemis, V. (2014). Analiza uhranjenosti kod dječaka i djevojčica mlađeg školskog uzrasta. *Bijeljinski metodički časopis*, 1(1), 41-48.
- Nicklas, A. T., Baranowski, T., Cullen, W. K., & Berenson, G. (2001). Eating Patterns, Dietary Quality and Obesity. *Journal of the American College of Nutrition*, 20(6), 599-608.
- Obradovic, B., & Srdic, B. (2007). Da li su dečaci mlađeg školskog uzrasta gojazni. *Sport Mont*, 5(12-13-14), 574-578.
- Popovic, S., Bjelica, D., Masanovic, B., & Vukotic, M. (2018). Describing physical activity profile of young Montenegrin females using the international physical activity questionnaire (IPAQ). In *Proceedings World Congress of Performance Analysis of Sport XII* (344). Opatija: International Society of Performance Analysis of Sport.
- Popovic, S., Bjelica, D., Vukotic, M., & Masanovic, B. (2018). Describing Physical Activity Profile of Older Montenegrin Females Using the International Physical Activity Questionnaire (IPAQ). In *Book of Abstracts 15th International Scientific Conference of Transformation Process in Sport "Sport Performance"* (60-61). Podgorica: Montenegrin Sports Academy.

**REVIEW PAPER**

# The Effects of a Knee Joint Injury Prevention Program on Young Female Basketball Players: A Systematic Review

Miljan Hadzovic<sup>1</sup>, Predrag Ilic<sup>1</sup>, Ana Lilic<sup>1</sup>, Mima Stankovic<sup>1</sup>

<sup>1</sup>University of Nis, Faculty of Sport and Physical Education, Nis, Serbia

## Abstract

The research results referring to frequency have indicated that most of the sports injuries among athletes of both genders occur in basketball and that knee injury is the second most frequent injury during sports activities. The anterior cruciate ligament (ACL) represents one of the four most important connections for knee stability, and it is frequently prone to injury during sports activities. The aim of this paper was to determine the effects of an exercise program on the prevention of injury to the anterior cruciate ligament of the knee joint among young female basketball players. To collect existing research on the effects of the applications of prevention programs on the prevention of ACL injury in young female basketball players, the following electronic databases were searched: PubMed, SCIndeks, PEDro, J-GATE, DOAJ and Google Scholar. The analyzed studies were published between 2003 and 2018 and the participants were young female basketball players. According to the results of this study, the most frequently used training programs were neuromuscular programs, whose structure includes several types of exercises and which represented a combination of plyometric exercises, core strengthening exercises, exercises to strengthen the muscles of the lower extremities, agility exercises, flexibility exercises, and balance exercises. Finally, the application of the knee injury training program leads to an improvement in motor balance, proprioceptive abilities, balance, flexibility, as well as biomechanical abilities related to injuries of the ACL, leading to an improvement in sports performance among female basketball players.

**Keywords:** Neuromuscular Training, ACL, Sports Injury

## Introduction

The emergence of television and directly televised sporting events, along with the desire to increase profit, have increased the popularity of certain sports among most of the global population, which has in turn led to a spike in the number of games and thus to increased movement and higher frequency of injuries among professional athletes (Matijević, 2014). Researches have indicated that female athletes who take part in sports such as basketball, volleyball, handball and football, which are dominated by jumps, pivots, frequent and rapid changes in the direction of movement, have a four to six times greater risk of injury of the knee joint than male athletes who take part in the same sports (Hewett, Stroupe,

Nance, & Noyes, 1996; Huston & Wojtys, 1996; Hewett, 2000). The increased risk of various injuries to the knee joint can be explained by the increased role of the valgus, which depends on the landing, that is, the specificities of each sport (Herrington, 2011). The research results referring to frequency have indicated that most of the sports injuries among athletes of both genders occur in basketball and that knee injury is the second most frequent injury, second only to injury of the ankle (Haycock & Gillette, 1976; Whiteside, 1980; Zelisko, Noble, & Porter, 1982).

As one of the most complex and largest joints of the human body, due to increased load of the locomotor system, the knee joint is prone to injury. This is a very frequent type of injury both

Correspondence:

**Montenegro Sport** Miljan Hadzovic  
 University of Nis, Faculty of Sport and Physical Education, Carnojevica 10A, Nis 18000, Serbia  
 E-mail: miljanhadzovic@gmail.com

among children and young adults, but also among athletes and the elderly. Knee injuries such as contusions, hematoma, fractures of the kneecap, fractures of other segments of the joint, and torn ligaments, are a consequence of increased movement or taking part in sports activities, a result of the direct or indirect effects of mechanical forces (Kosinac, 2002). In addition to these injuries caused by the effects of mechanical forces, certain deformities can also occur in the knee during the growth and development of the child, the most frequent of which is "knock-knees" (genu valgum) and "bowing" at the knee (genu varum), which may be a consequence of rickets, a weak diet, obesity and increased static load during standing or walking (Ulić, 1997). The knee joint connects the upper leg and the lower leg and includes three smaller joints, that is, the joint of the femur and tibia, the joint of the femur and kneecap, and the upper joint between the tibia and fibula. The movements which are performed in this joint are flexion, extension, and internal and external rotation (Müller, 1983). In the frontal plane, the normal curvature of the knee joint is 174° (the valgus position), and any and all smaller or greater deviations from this angle are labeled as "varus" or "valgus" knees, while the normal curvature in the sagittal plane has a value of 180°, thus an angle exceeding 185° among women and hyperextension among men is known as genu recurvatum (Begović, 2016). Furthermore, it is well known that the angle between the upper leg and lower leg („valgus“ of the knee) is greater among women, due to a wider and more shallow pelvic bone, as well as a shorter femur (Kosinac, 2002). For the functional stability of the knee, two types of stabilizers are responsible – the insertions of the surrounding muscles which generate force movement and stop movement, which can be active and passive, and which include surfaces of the joints, the tendons, menisci, joint capsules and gravitational force which limits the movement of the knee (Savić, 1999, taken from Đuričin, 2018). The anterior cruciate ligament (ACL – ligamentum cruciatum anterius) represents one of the four most important connections for knee stability, and it is frequently prone to injury during sports activities (Aglietti, Buzzi, Zaccherotti, & De Biase, 1994; Frank & Jackson, 1997; Hewett et al., 2005).

The aim of this paper was to determine the effects of an exercise program on the prevention of injury to the anterior cruciate ligament of the knee joint among young female basketball players. The tasks related to the goals of the research included: 1) searching electronic databases; 2) a compilation and translation of the literature from English; 3) analysis of the research results; and 4) presentation of the results, that is determining the effects of a sports injury prevention training program for the anterior cruciate ligament in the knee joint. After compiling the relevant data from the previously carried out experimental research dating from 2003 to 2018, and under the assumption that the exercise programs affect the stability and decrease in the number of injuries to the knee joint among female basketball players, an evaluation of the effects was carried out.

## Method

To collect existing research on the effects of the applications of prevention programs on the prevention of anterior cruciate ligament injury in the knee joint in young female basketball players, the following electronic databases were searched: PubMed, SCIndeks, PEDro, J-GATE, SCIndes, DOAJ and Google Scholar. The analyzed studies were published between 2003 and 2018. When surveying the databases, the following keywords were used: physical activity, knee valgus, landing, kinematics, ACL injury mechanism. The titles of the studies were identified, as were the abstracts and entire texts, which were then read and analyzed. The research was carried out by four authors, and the studies were analyzed in detail based on the set criteria.

For an experimental study to be included in the final analysis, it had to satisfy certain criteria: the participants in the research were individuals not afflicted by any chronic conditions, the participants were female basketball players of an average age of 15 to 23, the experimental group took part in a sports injury prevention training program for the knee joint on a sample of female basketball players, where measurements were taken and the effects of the applied program were evaluated, the research was written in English.

The experimental studies which met the set criteria were then analyzed and presented based on the following parameters: references (the initial of the author and year of publication), the sample of participants (health status, age, overall number and subgroups), the physical exercise program, the duration and frequency of the exercise, the intensity of the exercise, the research results.

The exclusion criteria included: studies which included only male participants, studies which included female participants whose average age did not range from 15 to 23, papers not published in English. This systematic review was undertaken in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Moher, Liberati, Tetzlaff, & Altman, 2009).

## Results

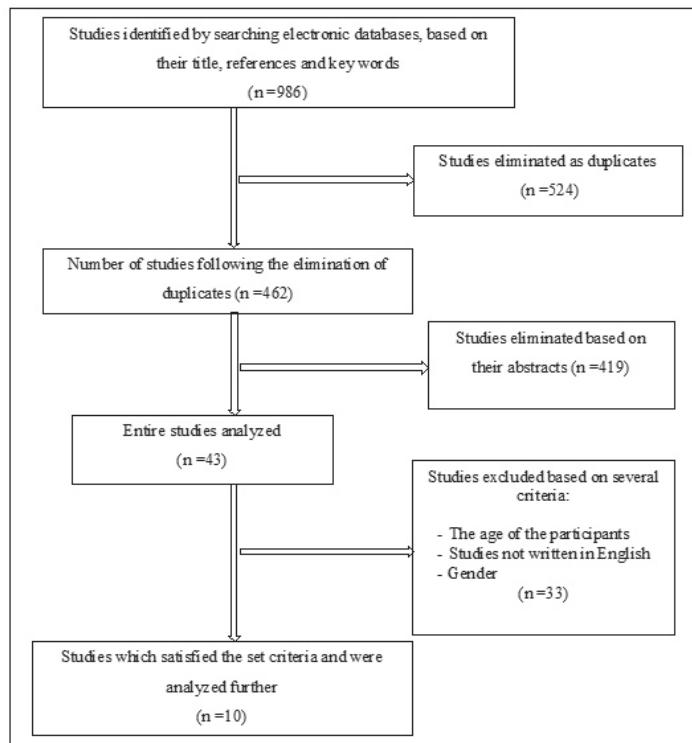
The survey of the electronic databases resulted in 986 studies on the topic of choice, primarily 524 studies were eliminated as duplicates, then 419 papers were rejected based on abstracts, while 33 studies were excluded and based on age and gender of the subjects, or were not written in English (graph 1). A further analysis and application of the set criteria, in accordance with the goals of this study, identified 10 experimental research programs which were included in the final analysis (Wilkerson et al., 2004; Chappell & Limpisvasti, 2008; Kato, Urabe, & Kawamura, 2008; Vescovi, Canavan, & Hasson, 2008; Lim et al., 2009; McLeod, Armstrong, Miller, & Sauers, 2009; Herrington, 2010; Nagano, Ida, Akai, & Fukubayashi, 2011; Bonato, Benis, & La Torre, 2018; Li, Liu, & Zhang, 2018).

## Discussion

Due to the increased number of matches, knee injuries are a frequent occurrence in intermittent sports with an increased number of jumps and rapid changes in rhythm and direction of movement, with a greater frequency of occurrence among female athletes than male ones (Dugan, 2005). The greater number of knee injuries among the female athletes is conditioned by the decrease in hip flexion and the knee during landing, instability of the knee joint, increased activation of the quadriceps and decreased activation of the knee tendon, which could lead to an increased risk of non-contact related injury of the anterior cruciate ligament (Chappell, Creighton, Giuliani, Yu, & Garrett, 2007).

Instability of the knee joint is defined as anterior, posterior, medial, lateral and rotational in relation to the movement of the lower leg, while the main structures which provide stability are the anterior cruciate ligament (ACL – ligamentum cruciatum anterius), the posterior cruciate ligament (PCL - ligamentu cruciatum posterius), the fibular collateral ligament (LCL – ligamentum collaterale laterale) and the medial collateral ligament (MCL - ligamentum collaterale mediale), (Begović, 2016). Bearing in mind that injury to the ACL is one of the most frequent injuries among female basketball players (Sallis, Jones, Sunshine, Smith & Simon, 2001), the aim of this research was to find effective exercise programs which could be used to prevent injury of this type in the knee joint among female basketball players.

The research results, presented in table form (Table 1), indicate that in all the analyzed studies included programs which use a combination of multiple types of exercises to strengthen the



**Graph 1:** A diagram of the course of analysis of the papers

muscles of the torso and the lower extremities, plyometric exercises, exercises to increase flexibility and balance, while the control group followed a regular basketball training program. As part of the introductory segment of regular basketball training during the course of the week, preventive programs were used in seven of the analyzed studies (Chappell & Limpisvasti, 2008; Kato et al., 2008; Lim et al., 2009; Herrington, 2010; Nagano et al., 2011; Bonato et al., 2018; Li et al., 2018). Two studies included specially organized training sessions for the prevention of injuries to the knee joint (Vescovi et al., 2008; McLeod et al., 2009), while one study carried out preventive exercises as part of the pre-season conditioning training (Wilkerson et al., 2004).

The training structure of the analyzed experimental training programs differed. The functional strengthening of the muscles of the lower extremities and exercises for the development of strength were used in all the analyzed studies, as one of the important factors in the prevention programs for noncontact injury to the ACL. In one study (Vescovi et al., 2008) the authors cited that in addition to the small sample of participants who took part in prevention program, the statistical progress in strength was another of the more important shortcomings. Core strengthening exercises were especially prominent as part of the prevention programs in five studies (Chappell & Limpisvasti, 2008; Lim et al., 2009; Herrington, 2010; Bonato et al., 2018; Li et al., 2018). Plyometric exercises were a constituent part of the program for the prevention of ACL injuries in all the studies, which were included to improve the mechanics and reduce force during landing. Seven of the analyzed studies included balance exercises in their programs (Chappell & Limpisvasti, 2008; Kato et al., 2008; McLeod et al., 2009; Herrington, 2010; Nagano et al., 2011), while four of the studies used agility exercises with rapid changes in intensity and direction of movement (Lim et al., 2009; McLeod et al., 2009; Herrington, 2010; Bonato et al., 2018).

The systematic overview of the included parameters noted a statistically significant effect of the exercise on the maximal angle of knee flexion in a study which included the so-called SIPTP

(Sports Injury Prevention Training Program), which lasted for a period of eight weeks (Lim et al., 2009) and in a study which included a neuromuscular training program that lasted for a period of six weeks (Chappell & Limpisvasti, 2008). There were no statistically significant effects in the study which was based on combined popular exercise training and balance exercises for a period of four weeks (Kato et al., 2008), which could be a consequence of the shorter duration of the program and the lower frequency of training sessions during the week. The specialized training program for injury prevention carried out in one of the studies (Lim et al., 2009) had a statistically significant influence on the increase in the distance between the knees, the decrease in the knee joint torque in extension and at the same time an increase in the abduction torque, which is in accordance with the claims made by previous authors, that this type of neuromuscular training enables female athletes to adapt and protect their ACL from high impulse load (Hewett, Myer, & Ford, 2006).

The results of one of the analyzed studies have indicated that the decrease in risk of injury to the ACL can be influenced by plyometric training with a duration of six weeks, which influences the improvement of the neuromuscular attributes, that is, influences the ratio between the lower leg and quadriceps (Wilkerson et al., 2004).

Progressive jump training over a period of four weeks, in one of the analyzed studies (Herrington, 2010), led to a statistically significant reduction in the angle of the knee in the valgus position during landing (for both legs). These results are similar to those of previous studies in which combined training was applied over an extended period of six weeks (Noyes., Barber-Westin, Fleckenstein, Walsh, & West, 2005).

In one of the analyzed studies (Li et al., 2018), neuromuscular training for a period of four weeks led to a statistically significant decrease in the reaction force to the surface, but not to any significant changes in the knee flexion, while in another study (Vescovi et al., 2008) plyometric training for a period of six weeks led to a decrease in the vertical reaction force of 17% to 18% in the case

**Table. 1:** A systematic overview and features included in the studies

Study (year)	Age of the participants (MEAN ± SD) (n)	Size of the sample (n)	Number of participants per group	Duration / Frequency (days/ weeks)	Type of activity	Results
Lim et al., (2009)	EG=16.2±1.2 KG=16.1±1.0	n=22 KG=11	EG=11 KG=11	8 weeks	20 min.	A training program aimed at preventing sports injuries (SIPTP):: a warm-up, stretching, strength training, plyometrics, agility and alternative exercises to calm the body down.  EG>KG MKFA ↑ p=0.023; KD ↑ p=0.005; HQR ↓ p=0.021; MKET ↓ p=0.124%; MKAT ↑ p=0.043
Chappell & Limpisvasti, (2008).	19.0±1.2	n=33	Female basketball players EG1=13 Female football players EG2=20	6 weeks 6/7	10-15 min.	A Neuromuscular Training Program - a combination of exercises (10) for strengthening the core muscles, dynamic stability of the joints and balance training, jump training, and plyometric exercises.  EG1 , EG2» DKVM ↓ p=0.04 DJ ¥ IKFA↑ p=0.003; MKFA ↑ p=0.006 JS ¥ VJ ↑ p=0.001; VJR ↑ p=0.001; VJL ↑ p=0.001
Herrington, (2010)	19.1±1	n=15	EG=15	4 weeks 3/7	15 min.	A neuromuscular progressive jump-training program which includes: plyometric training, core strength training, balance training, resistance training and interval speed training with changes in direction of movement.  EG » KG COH ↑ p=0.001; COHL ↑ p=0.001; COHR ↑ p=0.001; DJKVVAR ↓ p=0.001; DJKVAL ↓ p=0.002; JSKVVAR ↓ p=0.01; JSKVAL ↓ p=0.035
Kato et al., (2008).	EG=20.4±1.0 KG=20.5±0.9	n=20	EG=10 KG=10	4 weeks 3/7	20 min	Combined training of popular exercises: squat, forward lunge, jump landing, lunge walking, twist, balance exercises on one leg on the platform (BOSU®), balance exercises on both legs on the platform (BOSU®).  EG » KG following 2 weeks: CPA ↓ p<0.05; TA ↓ p<0.05 MKFA ¥ following 4 weeks: CPA ↓ p<0.05; TA ↓ p>0.05# MKFA ¥
McLeod et al., (2009)	EG=15.6±1.1 KG=16.0±1.3	n=50 KG=23	EG=27 KG=23	6 weeks 2/7	90 min	A Neuromuscular Training Program: warm-up exercises such as running, side movement, scissor movement and stretching, the main part of the training (circular training) with 4 stops, or strength exercises, plyometric exercises, agility exercises, balance with a ball exercises  EG » KG BESS ↓ p=0.003 SBESS ↓ p=0.033 SEBT↑ p=0.05
Wilkerson et al., (2004)	EG=19.0±1.4 KG=19.0±1.1	n=19 KG=8	EG=11 KG=8	6 weeks 3/7	X	A Plyometric Jump-Training Program, which consisted of 3 phases of progressive increase of the complexity and intensity of the jump, flexibility exercises, and isotonnic muscle strengthening.  EG » KG (GrV) HQR p=0.008

(continued on next page)

(continued from previous page)

Study (year)	Age of the participants (MEAN ± SD)	Size of the sample (n)	Number of participants per group	Duration / Frequency (days/ weeks)	Type of activity	Results
Li et al., (2018)	EGm=21.7±1.3 EGf=21.2±1.9 KGm=21.3±1.5 KGF=22.3±0.9	n=33	EGm=9 EGf=8 KGm=8 KGF=8	4 weeks Introductory part of the regular training	A neuromuscular training program for the prevention of ACL: warm-up, core strengthening exercise and proprioceptive exercises; exercises for strengthening the knee and hip muscles; plyometric jumps with feedback; relaxing activities, stretching and flexibility exercises.	EGm and EGf » VGRF ↓ p<0.05 PGRF ↓ p<0.05 KFA ¥
Vescovi et al., (2008)	EG=20.3±1.2	n=20	EG=10 KG=10	6 weeks 3/7	SportsmetricsTM - A Plyometric Training Program - basic exercises, technique exercise and exercises for the improvement of the performance of the jump and landing.	EG » KG VGRF ↓ p=0.122 ¥ VJ ↑ p=0.696 ¥
Bonato et al., (2018)	EG=20 ± 2 KG =20 ± 1	n = 160	EG = 86 KG = 74	8 months (98 training sessions during the regular season) 4/7	Bodyweight Neuromuscular Training; low intensity exercise with a ball; exercises of active stretching; exercises focused on the development of general strength; plyometric, jumping and balance exercises; speed running exercises and basketball movements with sudden changes in direction.	EG » KG TIT ↓ p=0.0001 TIM ↓ p=0.006 KS ↓ p=0.037 ACLL ↓ p=0.038 YEBTR ↑ p=0.007 YEBTR ↑ p=0.012 VJ ↑ p=0.04
Nagano et al., (2011)	EG = 19.4 ± 0.7	n = 8	EG = 8	5 weeks 3/7	Jump and balance training; an exercise phase for the improvement of the landing technique and an exercise phase for the performance of the jump/landing	EG » IKFA ↑ p<0.001 CPA ¥

M - male; F - female; X - unavailable; n - number of participants; EG - experimental group; KG - control group; p - level of statistical significance; EG»KG - differences in favor of the experimental group compared to the control group following the intervention; ↑ - improvement/increase; ↓ - decrease; ♯ - statistically significant effect of interaction between the groups and time; COH - single-leg cross jump for the distance (%); COHL - single-leg cross jump for the distance with the left leg (cm); COHR - single-leg cross jump for the distance with the right leg (cm); DJ - depth jump with a vertical takeoff; JS - jump during stop movement; VJ - vertical jump maximal height; VL - single-leg vertical jump, left leg, maximal height; VJR - single-leg vertical jump, right leg, maximal height; DJKVAR - valgus angle of the knee of the right leg when performing a depth jump, both feet, with a vertical takeoff (%); JSKVVAR - valgus angle of the knee of the right leg when performing a jump shot (%); CPA - knee joint angle (valgus/varus) in the frontal plane (°); KFA - knee flexion angle (°); MKFA - maximal angle of the knee flexion (°); IKFA - initial angle of flexion in the knee joint during landing; DKVM - dynamic valgus moment of the knee during stop movement; KD - distance between the knee of the left and right leg; HOR - relationship (ratio) between the lower leg and quadriceps; MKAT - maximal knee torque during extension; MKET - maximal knee torque during abduction; HQR - ratio between the maximal value of the torque of the hamstring/quadriceps at 60° s⁻¹; BESS (Balance Error Scoring System) - balance error scoring system when maintaining balance on one or both legs; SBESS - balance error scoring system when maintaining balance on one leg in a star shape; VGRF - vertical reaction force to the surface; PGRF - posterior vertical reaction force; TIT - total number of injuries during training; TIM - total number of injuries during matches; KS - number of knee sprains; ACLL - number of lesions in the anterior cruciate ligament; YEBTR (Y - Excursion balance test) - composite Y balance test of the left leg; YEBTR (Y - Excursion balance test) - composite Y balance test of the right leg.

of most of the female participants of the experimental group. The change was not statistically significant, but had clinical significance. The neuromuscular training also had an effect on the motor balance among female basketball players and can lead to a decrease in the risk of injury to the knee joint (McLeod et al., 2009).

Combined training programs, which in their structure contain strength exercises, jumps, and balance exercises (Kato et al., 2008) for a duration of four weeks, led to a statistically significant decrease in the angle of the knee joint (valgus/varus) in the frontal plane, while the application of the program consisting of jumps and balance exercises for a period of five weeks did not statistically significantly affect changes in this joint in the frontal plane, which could be a consequence of the lack of exercises for strengthening the muscles of the lower extremities.

By analyzing the compiled studies, it was concluded that there are several different programs which have a positive effect on the prevention of injury to the ACL in the knee joint among female basketball players. According to the results of this study, in the current research the most frequently used training programs are neuromuscular programs, whose structure includes several types of exercises and which represent a combination of plyometric exercises, core strengthening exercises, exercises to strengthen the muscles of the lower extremities, agility exercises, flexibility exercises, and balance exercises. Even though there are programs with a somewhat shorter duration, the greatest effects on the prevention of injury to the knee joint among female basketball players were realized in programs with a frequency of three training sessions per week, for a period of six or more weeks.

Finally, the application of the prevention training program for knee injury represents a very important part of every organized and planned training process, since it leads to an improvement in motor balance, proprioceptive abilities, balance, flexibility, as well as biomechanical abilities related to injuries of the ACL, leading to an improvement in the sports performance among female basketball players.

#### Acknowledgements

There are no acknowledgements.

#### Conflict of Interest

The authors declare that there are no conflicts of interest.

**Received:** 8 September 2019 | **Accepted:** 18 November 2019 | **Published:**

10 January 2020

#### References

- Aglietti, P., Buzzi, R., Zaccherotti, G., & De Biase, P. (1994). Patellar tendon versus doubled semitendinosus and gracilis tendons for anterior cruciate ligament reconstruction. *The American journal of sports medicine*, 22(2), 211-218.
- Begović, N.N. (2016). Utvrđivanje faktora rizika idiopatskog bola u kolenu kod adolescenata. Neobjavljena doktorska disertacija. Beograd: Univerzitet u Beogradu, Medicinski fakultet.
- Bonato, M., Benis, R., & La Torre, A. (2018). Neuromuscular training reduces lower limb injuries in elite female basketball players. A cluster randomized controlled trial. *Scandinavian journal of medicine & science in sports*, 28(4), 1451-1460.
- Chappell, J.D., & Limpisvasti, O. (2008). Effect of a neuromuscular training program on the kinetics and kinematics of jumping tasks. *The American journal of sports medicine*, 36(6), 1081-1086.
- Chappell, J.D., Creighton, R.A., Giuliani, C., Yu, B., & Garrett, W.E. (2007). Kinematics and electromyography of landing preparation in vertical stop-jump: risks for noncontact anterior cruciate ligament injury. *The American journal of sports medicine*, 35(2), 235-241.
- Dugan, S.A. (2005). Sports-related knee injuries in female athletes: what gives? *American journal of physical medicine & rehabilitation*, 84(2), 122-130.
- Đuričin, A. (2018). Prostorno određivanje položaja kalema u golenjači posle rekonstrukcije prednjeg ukrštenog ligamenta kolena. Neobjavljena doktorska disertacija. Novi Sad: Univerzitet u Novom Sadu, Medicinski fakultet.
- Frank, C.B., & Jackson, D.W. (1997). The science of reconstruction of the anterior cruciate ligament. *The Journal of Bone & Joint Surgery*, 79(10), 1556-1576.
- Haycock, C.E., & Gillette, J. V. (1976). Susceptibility of women athletes to injury: myths vs reality. *Jama*, 236(2), 163-165.
- Herrington, L. (2010). The effects of 4 weeks of jump training on landing knee valgus and crossover hop performance in female basketball players. *The Journal of Strength & Conditioning Research*, 24(12), 3427-3432.
- Herrington, L. (2011). Knee valgus angle during landing tasks in female volleyball and basketball players. *The Journal of Strength & Conditioning Research*, 25(1), 262-266.
- Hewett, T.E. (2000). Neuromuscular and hormonal factors associated with knee injuries in female athletes. *Sports medicine*, 29(5), 313-327.
- Hewett, T.E., Myer, G.D., & Ford, K.R. (2006). Anterior cruciate ligament injuries in female athletes: Part 1, mechanisms and risk factors. *The American journal of sports medicine*, 34(2), 299-311.
- Hewett, T.E., Stroupe, A.L., Nance, T.A., & Noyes, F.R. (1996). Plyometric training in female athletes: decreased impact forces and increased hamstring torques. *The American journal of sports medicine*, 24(6), 765-773.
- Hewett, T., Myer, G., Ford, K., Heidt, R., Colosimo, A., McLean, S., van den Bogert, A., Paterno, M., & Succop, P. (2005). Biomechanical measures of neuromuscular control and valgus loading of the knee predict anterior cruciate ligament injury risk in female athletes: a prospective study. *The American journal of sports medicine*, 33(4), 492-501.
- Huston, L.J., & Wojtys, E.M. (1996). Neuromuscular performance characteristics in elite female athletes. *The American journal of sports medicine*, 24(4), 427-436.
- Kato, S., Urabe, Y., & Kawamura, K. (2008). Alignment control exercise changes lower extremity movement during stop movements in female basketball players. *The Knee*, 15(4), 299-304.
- Kosinac, Z. (2002). *Kineziterapija sustava za kretanje*. Split: Udruga za šport i rekreaciju djece i mladeži grada Splita.
- Li, H., Liu, H., & Zhang, X. (2018). The effectiveness of neuromuscular training with augmented feedback on acl injury prevention. *ISBS Proceedings Archive*, 36(1), 948-951.
- Lim, B.O., Lee, Y.S., Kim, J.G., An, K.O., Yoo, J., & Kwon, Y.H. (2009). Effects of sports injury prevention training on the biomechanical risk factors of anterior cruciate ligament injury in high school female basketball players. *The American journal of sports medicine*, 37(9), 1728-1734.
- Matijević, R. (2014). *Propriocepција zglobov kolena posle kidanja prednjeg ukrštenog ligamenta kod profesionalnih sportista*. Neobjavljena doktorska disertacija. Novi Sad: Univerzitet u Novom Sadu, Medicinski fakultet.
- McLeod, T.C.V., Armstrong, T., Miller, M., & Sauers, J.L. (2009). Balance improvements in female high school basketball players after a 6-week neuromuscular-training program. *Journal of sport rehabilitation*, 18(4), 465-481.
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Annals of internal medicine*, 151(4), 264-269.
- Müller, W. (1983). *The knee: form, function, and ligament reconstruction*. Berlin: Springer Science & Business Media.
- Nagano, Y., Ida, H., Akai, M., & Fukubayashi, T. (2011). Effects of jump and balance training on knee kinematics and electromyography of female basketball athletes during a single limb drop landing: pre-post intervention study. *Sports Medicine, Arthroscopy, Rehabilitation Therapy & Technology*, 3(1), 1-8.
- Noyes, F.R., Barber-Westin, S.D., Fleckenstein, C., Walsh, C., & West, J. (2005). The drop-jump screening test: difference in lower limb control by gender and effect of neuromuscular training in female athletes. *The American journal of sports medicine*, 33(2), 197-207.
- Sallis, R.E., Jones, K., Sunshine, S., Smith, G., & Simon, L. (2001). Comparing sports injuries in men and women. *International journal of sports medicine*, 22(06), 420-423.
- Ulić, D. (1997). *Osnove kineziterapije*. Novi Sad: Faculty of Physical Education.
- Vescovi, J.D., Canavan, P.K., & Hasson, S. (2008). Effects of a plyometric program on vertical landing force and jumping performance in college women. *Physical Therapy in Sport*, 9(4), 185-192.
- Whiteside, P. A. (1980). Men's and women's injuries in comparable sports. *The Physician and sports medicine*, 8(3), 130-140.
- Wilkerson, G.B., Colston, M.A., Short, N.I., Neal, K.L., Hoewischer, P.F., & Pixley, J.J. (2004). Neuromuscular Changes in Female Collegiate Athletes Resulting From a Plyometric Jump-Training Program. *Journal of Athletic Training*, 39(1), 17-23.
- Zelisko, J.A., Noble, H.B., & Porter, M. (1982). A comparison of men's and women's professional basketball injuries. *The American journal of sports medicine*, 10(5), 297-299.

**SHORT REPORT**

# Report of the International Conference in Sport Science “ICSS 2019” of the Sports University of Tirana

Juel Jarani<sup>1</sup><sup>1</sup>Sport University of Tirana, Tirana, Albania**Abstract**

The article is providing highlights of the Report of the International Conference in Sport Science “ICSS 2019”, hosted by the Sports University of Tirana. The event was held on December 6-7, 2019 in Tirana, Albania. The Conference provided space for presentation research papers and related discussion, as well as for poster sessions. The Conference was officially opened in the large conference hall of the Sports University of Tirana by prof. Agron Cuka, PhD, Rector of the Sports University of Tirana and chairman of the Conference scientific committee. This prestigious event gathered 264 authors and 84 participants, coming from 7 countries.

**Keywords:** *Scientific Conference, Sport Science, Sports University, Tirana*

**Introduction**

The greatest international event from the area of sports sciences was successfully held in Tirana, Albania this year. Namely, it was known that a severe earthquake struck Albania a few days ago. Therefore, the organizing committee thanked the guests who still came in large numbers and supported them in these difficult moments.

The International Scientific Conference “ICSS 2019” was hosted by the Sports University of Tirana on December 6-7, 2019 in Tirana. It has been considered as very important scientific events related to the sports sciences in the region, which helps connectivity and scientific collaboration which is necessary if the countries of the Western Balkans want to follow world trends and continuous progress in this area. The conference that was firmly confirmed the quality as it hosted 264 authors and 84 participants from 7 countries.

This year's conference is the third in a row organized by the Sports University of Tirana (2014, 2017, 2019). The quality and number of participants has exceeded the previous two, and the organizers hope that the quality will grow from year to year. The conference provided the platform for researchers and experts who had an opportunity for networking through discussions and exchange on the international level. This event gave an opportunity for experts not only to network, but also to share ideas and present their research to a worldwide community.

In the words of the conference president prof. Agron Cuka, PhD, the physical activity has a very important role in improving people's life and for that reason, the scientific research is growing up rapidly and our university is giving its contribution. It is very important that in these activities we have partners in Balkan and Europe and we are trying to improve our cooperation to ameliorate in every field of our activity.

Correspondence:

**Montenegro Sport**

J. Jarani  
Sport University of Tirana, Rruga Muhamet Gjollesha, 1001 Tiranë, Albania  
E-Mail: jjarani@ust.edu.al



**Picture 1.** Opening ceremony

The theme of this Conference "Sports Science Toward the Future" and its content shows our intention to promote quality physical education (including health, movement related physical activity, recreation etc.) and sport especially in the schools and other learning institutions, by emphasizing the importance of daily physical exercise and facilitating better method-

ologies for being healthy through taking active lifestyle for all age groups regardless any form of disabilities. This conference provides a show case for developments in the fields of physical activity and sport and we can learn from each other by sharing experiences and lessons, said Prof. Agron Cuka, PhD, conference president.



**Picture 2.** Conference president PROF. AGRON CUKA, PHD

After the conference president, the meeting was welcomed by prof. Ramona Lile, PhD, Rector of the University of Arad "Aurel Vlaicu", prof. Zsombor Lacza, PhD, vice-rector of the University of Physical Education, Budapest, prof. Tomislav Kris-

ticevic, PhD, dean of the Faculty of Kinesiology in Zagreb, prof. Ivanka Gajic, PhD, dean of the Faculty of Sports in Belgrade and prof. Ibrahim Kubilay, PhD, Erasmus+ Coordinator of Suleiman Demirel University of Isparta.



**Picture 3.** Session 4, Social Sciences-Legislation and Sport Management

The ceremony was followed by a plenary session in which they lectured, prof. Zsombor Lacza, PhD, from Hungary, assist. prof. Bojan Masanovic, PhD, from Montenegro, prof. Tomislav Krističević, PhD, from Croatia, prof. Liviu Andreu, PhD, from Romania, prof. Uros Mitrovic, PhD, from Belgrade and prof. Fadil Mamuti from Macedonia.

The program continued with an oral session focusing on Physical Education, Training and Performance, followed by a poster session that ended today's program.

On the second day of the conference there are three sessions on the program, the first on the topic of Social Sciences and Sports Management and the second and the third on the topic of Physical Activity and Health.

This was followed by the closing ceremony of the conference in the afternoon and another address by the rector, Prof. Agron

Cuka, PhD, who thanked the guests, wished them happy holidays, and invited them to be in the same place next year.

#### Acknowledgements

There are no acknowledgements.

#### Conflict of Interest

The authors declare that there are no conflicts of interest.

**Received:** 7 December 2019 | **Accepted:** 23 December 2019 | **Published:** 10 January 2020

#### References

Sports University of Tirana. (2019). *Book of Abstract of the International Conference in Sport Science "ICSS 2019"*. Tirana: Sports University of Tirana.  
International Conference in Sports Science. (2019). *Programme ICSS 2019*. Available from Sports University of Tirana website: <http://ust.edu.al/wp-content/uploads/2019/12/PROGRAM-ICSS-2019.pdf>.



# Guidelines for Authors

Revised October 2017

\*\*\* 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 *Journal of Anthropology of Sport and Physical Education* (JASPE) applies the Creative Commons Attribution (CC BY) license to articles and other works it publishes.

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.

JASPE 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.

JASPE honors 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 or Montenegrin language. Chosen language standards 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

JASPE 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 anthropology of sport and physical education from five major fields of anthropology: cultural, global, biological, linguistic and medical. 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 anthropology of sport and physical education from five major fields of anthropology: cultural, global, biological, linguistic and medical.

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 JASPE.

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 JASPE editorial board. JASPE also publishes award papers selected by the scientific committee of the publisher's conferences.

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

JASPE only accepts electronic submission to the e-mail of the Journal Office: [jaspe@ac.me](mailto:jaspe@ac.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 JASPE, 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

A 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 JASPE;
- 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 JASPE.

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.

JASPE 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. Open Access License and Publisher Copyright Policies



JASPE applies the Creative Commons Attribution (CC BY) license to articles and other works it publishes. If author(s) submit its paper for publication by JASPE, they agree to have the CC BY license applied to their work. Under this Open Access license, the author(s) agree that anyone can reuse their article in whole or part for any purpose, for free, even for commercial purposes. Anyone may copy, distribute, or reuse the content as long as the author(s) and original source are properly cited. This facilitates freedom in re-use and also ensures that JASPE content can be mined without barriers for the needs of research. On the other hand, the author(s) may use content owned by someone else in their article if they have written permission to do so. If the manuscript contains content such as photos, images, figures, tables, audio files, videos, et cetera, that the author(s) do not own, JASPE will require them to provide it with proof that the owner of that content has given them written permission to use it, and has approved of the CC BY license being applied to their content. Otherwise, JASPE will ask the author(s) to remove that content and/or replace it with other content that you own or have such permission to use. JASPE provides a form the author(s) can use to ask for and obtain permission from the owner.

In addition, the author(s) may freely use the content they previously published in a paper through another publisher and they own the rights to that content; however, that's not necessarily the case and it depends on the license that covers the other paper. Some publishers allow free and unrestricted reuse of article content they own, such as under the CC BY

license. Other publishers use licenses that allow reuse only if the same license is applied by the person or publisher reusing the content. If the article was published under a CC BY license or another license that allows free and unrestricted use, the author(s) may use the content in the submitted manuscript provided that the author(s) give proper attribution, as explained above. If the content was published under a more restrictive license, the author(s) must ascertain what rights they have under that license. JASPE advises the author(s) not to include any content in the submitted manuscript which they do not have rights to use, and always give proper attribution.

The editors of JASPE consider plagiarism to be a serious breach of academic ethics. Any author who practices plagiarism (in part or totality) will be suspended for six years from submitting new submissions to JASPE. 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 will result in immediate rejection of the manuscript.

JASPE 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 JASPE 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.

## 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 JASPE. 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 [jaspe@ac.me](mailto:jaspe@ac.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



JASPE 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:

Analysis of Dietary Intake and Body Composition of Female Athletes over a Competitive Season

Original Scientific Paper

Diet and Body Composition of Female Athletes

Svetlana Nepocatych<sup>1</sup>, Gytis Balilionis<sup>1</sup>, Eric K. O'Neal<sup>2</sup>

<sup>1</sup>Elon University, Department of Exercise Science, Elon, NC 27215

<sup>2</sup>University of North Alabama, Department of Health, Physical Education and Recreation, Florence, AL 35632

Corresponding author:

*S. Nepocatych*

*Elon University*

*Department of Exercise Science*

*100 Campus Dr.*

*2525 CB*

*Elon, NC 27244*

*United States*

*E-mail: snepocatych@elon.edu*

Word count: 2,946

Word count: 4259

Abstract word count: 211

Number of Tables: 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, Author's Affiliations, Abstract and Key words must be in English (for both each chosen language of full paper). 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

JASPE 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

JASPE 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 Krstrup (2008) stated that
- ✓ Subsequent 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

- ✓ Krstrup et al. (2003) studied
- ✓ In one study (Krstrup 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):

Nepocatych, S., Balilionis, G., & O'Neal, E. K. (2017). Analysis of dietary intake and body composition of female athletes over a competitive season. *Montenegrin Journal of Sports Science and Medicine*, 6(2), 57-65. doi: 10.26773/mjssm.2017.09.008

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. doi: 10.1007/s00421-007-0468-x

Krstrup, 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. doi: 10.1249/01.MSS.0000058441.94520.32

Journal article (online; electronic version of print source):

Williams, R. (2016). Krishna's Neglected Responsibilities: Religious devotion and social critique in eighteenth-century North India [Electronic version]. *Modern Asian Studies*, 50(5), 1403-1440. doi:10.1017/S0026749X14000444

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/news/events/hydration](http://www.rcn.org.uk/news/events/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. <sup>a,b,c</sup>), and order the superscripts from left to right, top to bottom. Each table's first footnote must be the superscript <sup>a</sup>.

- ✓ <sup>a</sup>One participant was diagnosed with heat illness and n = 19.<sup>b</sup>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. JASPE 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 JASPE.

#### 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 below 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

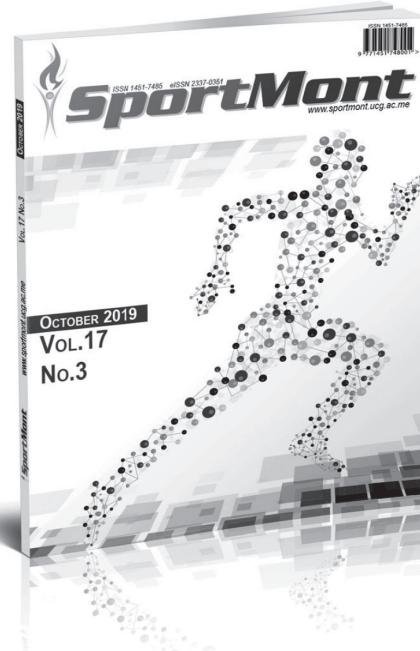
Signs should be placed immediately preceding the relevant number.

✓ 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*



ISSN 1451-7485

Sport Mont Journal (SMJ) is a print (ISSN 1451-7485) and electronic scientific journal (eISSN 2337-0351) 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.

SMJ is published three times a year, in February, June and October of each year. SMJ 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.

SMJ 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 SMJ website: <http://www.sportmont.ucg.ac.me/?sekacija=page&p=51>. Contributors are urged to read SMJ's guidelines for the authors carefully before submitting manuscripts. Manuscripts submissions should be sent in electronic format to [sportmont@ac.me](mailto:sportmont@ac.me) or contact following Editors:

**Dusko BJELICA**, *Editor-in Chief – [dbjelica@ucg.ac.me](mailto:dbjelica@ucg.ac.me)*  
**Zoran MILOSEVIC**, *Editor-in Chief – [zoranais@eunet.rs](mailto:zoranais@eunet.rs)*  
**Jovan GARDASEVIC**, *Managing Editor – [jovan@ucg.ac.me](mailto:jovan@ucg.ac.me)*

**Publication date:** Winter issue – February 2019  
Summer issue – June 2019  
Autumn issue – October 2019

# University of Montenegro

Cetinjska br.2  
81 000 Podgorica  
Montenegro

E-mail:  
[rektor@ac.me](mailto:rektor@ac.me)  
[rektorat@ac.me](mailto:rektorat@ac.me)

Phone: + 382 20 414 255  
Fax: + 382 20 414 230

Web:  
[www.ucg.ac.me](http://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 programmes 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](http://www.ucg.ac.me) or send e-mail to [pr.centar@ac.me](mailto:pr.centar@ac.me).





## USEFUL CONTACTS

### Editorial enquiries and journal proposals:

Dusko Bjelica  
Stevo Popovic  
Editors-in-Chief  
Email: [office@mjssm.me](mailto:office@mjssm.me)

Selcuk Akpinar  
Executive Editor  
Email: [office@mjssm.me](mailto:office@mjssm.me)

**Marketing enquiries:**  
Jovan Gardasevic  
Marketing Manager  
Email: [administration@mjssm.me](mailto: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

Editors-in-Chief: **Dusko Bjelica**, Montenegro; **Zoran Milosevic**, Serbia  
Managing Editor: **Jovan Gardasevic**, Montenegro

Volume 17, 2019, 3 issues per year; Print ISSN: 1451-7485, Online ISSN: 2337-0351

Sport Mont Journal is a scientific journal that 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. SMJ is published three times a year, in February, June and October of each year. SMJ 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.

[www.sportmont.ucg.ac.me](http://www.sportmont.ucg.ac.me)

### Montenegrin Journal of Sports Science and Medicine

Editors-in-Chief: **Dusko Bjelica**, Montenegro; **Stevo Popovic**, Montenegro  
Executive Editor: **Selçuk Akpinar**, Turkey  
Associate Editors: **Mehmet Uygur**, USA; **Catalina Casaru**, USA; and **Predrag Bozic**, Serbia

Volume 8, 2019, 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](http://www.mjssm.me)



## 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/?sekacija=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](mailto:office@mjssm.me) or contact following Editors:

**Dusko BJELICA**, Editor-in Chief – [dbjelica@ucg.ac.me](mailto:dbjelica@ucg.ac.me)

**Stevo POPOVIC**, Editor-in Chief – [stevop@ucg.ac.me](mailto:stevop@ucg.ac.me)

**Selçuk AKPINAR**, Executive Editor – [sakpinar@nevsehir.edu.tr](mailto:sakpinar@nevsehir.edu.tr)

**Publication date:** Spring issue – March 2019  
Autumn issue – September 2019



## Faculty for sport and physical education NIKŠIĆ

Phone: + 382 40 235 204; Fax: + 382 40 235 207, +382 40 235 200  
E-mail: fakultetzasportnk@ac.me; Web: [www.ucg.ac.me/sport](http://www.ucg.ac.me/sport)

*Znanje i zdravlje!*



Univerzitet Crne Gore

# UNIVERZITET CRNE GORE INSTITUT ZA BIOLOGIJU MORA



University of Montenegro – Institute for marine biology is located in Kotor, Montenegro. Since its establishment in 1961, the Institute performed comprehensive research of the marine and coastal area, which has its wide impact to the environmental protection, pollution-prevention and practical application. Core competencies of the Institute are focused on research in the fields of marine conservation, ichthyology and marine fisheries, marine chemistry, aquaculture, plankton research, neuro and eco-physiology. The main research area is investigating and protection of Adriatic sea with special interest of South Adriatic area. Institute for marine biology have a wide range of international cooperation with Marine research institutions and Universities all over Mediterranean area trough a numerous Eu funded scientific projects.

All over the year Institute is looking to hire a young students from the field of general biology, marine biology, marine chemistry, molecular biology or similar disciplines on voluntary basis to work with us. We need opportunity for international internship or MSc or PhD thesis that could be performed on Institute in our 5 different labs: Fisheries and ichthyology, Aquaculture, Marine chemistry, Plankton and sea water quality and Benthos and marine conservation.

Every year Institute organize several summer schools and workshop for interested students, MSc and PhD candidates. From 01-05 July 2019 we will organize Summer school "Blue Growth: emerging technologies, trends and opportunities" in frame of InnoBlueGrowth Project who is financed by Interreg Med programme. Through the specific theme courses, workshops and working labs offered – covering different areas of the blue economy – the Summer School aims at encouraging young people involvement in blue economy sectors by offering high-quality technical knowledge and fostering their entrepreneurial spirit. The Summer School will facilitate fruitful exchanges and a stronger understanding among a variety of actors coming from different Mediterranean countries with diverse profiles, including representatives from the academia, the public and private sectors, but also potential funders and investors. These activities will count on specific team building activities for participants as well to reinforce interpersonal skills and foster cohesion among blue academia and sectors.

If You are interested apply on the following link: <https://www.ucg.ac.me/objava/blog/1221/objava/45392-ljetnja-skola-plavi-rast-nove-tehnologije-trendovi-i-mogucnosti>

**University of Montenegro – Institute for marine biology**

**Dobrota bb, P.o. box 69. 83550 Kotor, Montenegro**

**ibmk@ucg.ac.me**

**+38232334569**

**www.ucg.ac.me/ibm**



## *Faculty of Economics* *University of Montenegro*

The Faculty of Economics celebrated its 57th anniversary this year, and it is the oldest higher education institution in the country. Since its establishment, 8,630 students graduated at our Faculty.

Today, Faculty of Economics is a largely interdisciplinary institution, characterized by expressed dynamism in its work. Employees at the Faculty are dedicated to constant improvements and enhancements, all in accordance with the needs brought by the changes.

We provide our students with the best theoretical and practical knowledge, enabling them to develop critical spirit in approaching economic phenomena and solving concrete problems in daily work. From September 2017, at the Faculty, the new generation will start a 3 + 2 + 3 study, which will improve the quality of studying.

Development of Faculty of Economics in the coming period will follow the vision of development of the University of Montenegro, pursuing full achievement of its mission

Comprehensive literature, contemporary authors and works have always been imperative in creation of new academic directions at Faculty of Economics, which will form the basis of our future.

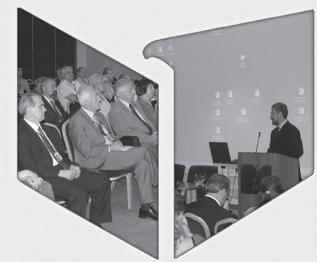
Faculty and its employees are dedicated to developing interest in strengthening the entrepreneurial initiative, creative and interdisciplinary approach among young people, using modern teaching and research methods. In this regard, the Faculty has modern textbooks and adequate IT technology, which supports the objectives set.





[www.ucg.ac.me/mf](http://www.ucg.ac.me/mf)

# UNIVERSITY OF MONTENEGRO FACULTY OF MECHANICAL ENGINEERING Podgorica



Mechanical engineering studies in Montenegro started during the school year 1970/71. On April 15th, within the Technical Faculty, the Department of Mechanical Engineering was formed. The Department of Mechanical Engineering of the Technical Faculty was transformed in 1978 into the Faculty of Mechanical Engineering, within the University "Veljko Vlahović". Since 1992 the Faculty of Mechanical Engineering is an autonomous University unit of the University of Montenegro. It is situated in Podgorica.

The University of Montenegro is the only state university in the country, and the Faculty of Mechanical Engineering is the only faculty in Montenegro from the field of mechanical engineering.

Activities of the Faculty of Mechanical Engineering can be divided into three fields: teaching, scientific-research work and professional work.

Two study programmes were accredited within the Faculty of Mechanical Engineering:

- Academic study programme MECHANICAL ENGINEERING
- Academic study programme ROAD TRAFFIC

The study programmes are realised according to the Bologna system of studies in accordance to the formula 3+2+3.

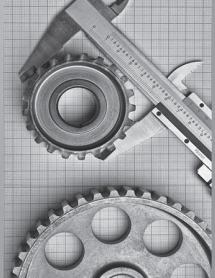
On the study program Mechanical Engineering it is possible to study next modules:

- Mechanical Engineering – Production
- Applied Mechanics and Construction
- Energetics
- Energy Efficiency
- Mechatronics
- Quality



At the Faculty of Mechanical Engineering, as organisational units, there are centres and laboratories through which scientific-research and professional work is done:

- Centre for Energetics
- Centre for Vehicles
- Centre for Quality
- Centre for Construction Mechanics
- Centre for Traffic and Mechanical Engineering Expertise
- Centre for transport machines and metal constructions
- 3D Centre
- Didactic Centre – Centre for Automation and Mechatronics training
- European Information and Innovation Centre
- Cooperation Training Centre
- Laboratory for Metal Testing
- Laboratory for Turbulent Flow Studies
- Laboratory for Vehicle Testing
- Laboratory for Attesting of Devices on the Technical Examination Line



**CRNOGORSKI OLIMPIJSKI KOMITET  
MONTENEGRIN OLYMPIC COMMITTEE**

CIP – Каталогизација у публикацији  
Национална библиотека Црне Горе, Цетиње

ISSN 2536-569X  
COBISS.CG-ID 33826832

MSA Conference 2020

# 17th Annual Scientific Conference of Montenegrin Sports Academy "Sport, Physical Activity and Health: Contemporary Perspectives"

<http://www.csakademija.me/conference/>



2<sup>th</sup> - 5<sup>th</sup> April 2020,  
Dubrovnik - Croatia