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Journal of Anthropology of Sport and Physical Education

ORIGINAL SCIENTIFIC PAPER

A Biomechanical Analysis of the Free Throw Shooting Technique in Wheelchair Basketball: A Pilot Study

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Abstract

The aim of this pilot study is to determine the kinematic elements of the free throw shooting technique among wheelchair basketball players from various classes. Three wheelchair basketball players from the wheelchair basketball club "Nais" took part in the study. The players were classified from IWBF classification 1, 3 and 4.5. All of the participants were right-handed. Free throw shooting recording were made with a fixed camera with a 1920 x 1080p resolution, 30 frames per s, positioned at a height of 1.20 m on the right side of the players facing the basket, at a distance of 7.5 m and 25 cm behind the free throw line. The "Kinovea" video program was used to process the results and the kinematic data for the free throw shooting technique of wheelchair basketball players. The kinematic parameters indicate differences in the performance of the free throw shooting technique among wheelchair basketball players from class 1, 3 and 4.5. A difference in successful throws between the participants from class 1, 3 and 4.5: the angle of ball release 50°, 52° and 47°, velocity of ball release 7.58 m/s, 6.25 m/s and 7.27 m/s, and height of ball release 164.49 cm, 180.71 cm and 190.86 cm, while the temporal parameters and angles of the elbow had the same values. We can conclude that for the successful performance of the free throw shooting technique a basketball player needs to achieve greater height of ball release in the final position.

Keywords: *Wheelchair Basketball, Free Throw Technique, Biomechanical Analysis*

Introduction

Wheelchair basketball is the most popular sport among individuals with disability. In addition, this sport allows athletes with different degrees of injury or disability to compete together (Brasile & Hedrick, 1996; Goosey-Tolfrey, Butterworth, & Morriss, 2002). Players are classified based on degree of disability (www.iwbf.org) (class 1.0, 2.0, 3.0, 4.0 and 4.5) while there are four more subclasses for borderline cases (classes 1.5, 2.5 and 3.5) (Paulson & Goosey-Tolfrey, 2017). Basketball players from class 1 have the highest level of disability and the lowest seated position balance, while players from class 4.5 have minimal disability (Malone, Gervais, Baudin, & Steadward, 1995; Malone, Gervais, & Steadward, 2002). The classes are defined based on the movements of the torso and seated position balance (International Wheelchair Basketball Federation, 2019). The total number of players together on the court cannot exceed 14 during a game (Malone, Nielsen, & Steadward, 2000).

For wheelchair basketball players, as in the case of a standup basketball players, throwing precision is one of the most important factors of success. The throw which is considered the easiest and which gives an individual the opportunity to unimpededly perform the shooting technique is the free throw (Brancazio, 1981; Malone et al., 2000). World championships were won in critical times of tied scores by successful free throws. Up to 70% of free throws were noted in the NBA league of the US, while the average for wheelchair basketball players ranges between 45-55% (Malone, Gervais, & Steadward, 1999; Malone et al., 2000). Of the overall percentage of points scored during a game 20 to 30%

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originate from the free throw (Malone et al., 2000). As a result, knowing the kinematic parameters of the proper shooting technique for individuals with various levels of disability can help to improve the success rate of the basketball team (Malone et al., 1999; Malone et al., 2000).

In wheelchair basketball, when it comes to the height of ball release, even during a free throw the initial height is much lower than that of stand up basketball (Thiboutot, 1999). If the elbow is not fully extended when performing the shooting technique, then it is more difficult for the wheelchair player to achieve the necessary force for the ball to reach the rim of the basket and achieve the ideal shot trajectory (Thiboutot, 1999). Success in wheelchair basketball depends to a great extent on numerous factors, including the mechanics of the players, their morphology, the position of the wheelchair, arm strength and stability of the torso, all of which can lead to player mistakes when performing a successful throw (Malone et al., 2000). Players from class 1, according to the international wheelchair basketball classification, have the least favorable seated position in their wheelchair. In addition, players in this class have a lower initial height of ball release during the throw. They also have different kinematic parameters compared to other wheelchair basketball players from other classes. There are also inter-class kinematic parameter differences among the remaining classes. Depending on their level of disability, players are impeded from prolonged musculature activation when performing the shooting technique to a greater and lesser extent, which in turn affects the precision of the throw (Malone et al., 1995; Malone et al., 1999).

The aim of this pilot study is to determine the kinematic elements of the free throw shooting technique among wheelchair basketball players from various classes. Because practicing the correct technique of a free throw shot can lead to an improvement in the players' contribution and thus affect the final result of the match.

Methods

The sample of participants

For the purpose of the pilot study, three male wheelchair players from the wheelchair basketball club "Nais" were recorded. The first participant was from class 1.0 (39 years); second player was from class 3.0 (34 years); and third player was from class 4.5 (38 years). The first participant was from class 1, the second from class 3, and the third from class 4.5. All of the participants were right-handed. The survey was conducted following the principles of the Declaration of Helsinki.

The research

The pilot study was carried out in the sports hall of the Cair sports facilities in Nis, Serbia, on December 20, 2019 from 10:00h to 11:00h. It was overseen by experienced researchers who set and checked the equipment needed to perform the experiment. The fixed camera "Sony", enabled a video recording of 30 frames per s, with a resolution of 1920x1080. It was positioned at the center of the extended foul line at a distance of 7.5 m from the center of the free throw line, and 25 cm behind the free throw line. The players took part in a standard training session, following a predetermined plan and program designed by the coach at the wheelchair basketball club "Nais", where they performed free throws after the session. Each participant performed one successful and one unsuccessful free throw. We used reflected markers in center of joints: center of the right wrist joint; right elbow (between lateral epicondyle of humerus and head of radius); right shoulder (greater tubercle of the humerus); right hip (greater trochanter of the femur); center of the ball, of right arm (shooting arm) from frontal axis (Malone et al., 2002).

Data analyses

The video recording of the experiment was analyzed using the "Kinovea" program for video analysis.

The kinematic parameters were assessed from three positions: the first was when player was in starting position before initial start of movement of arms that hold the ball: the second position was when player was achieved maximal elbow height through movement of free throw shoot, and the third position-final position was right before ball releasing moment (last contact with tips of fingers which add movement to the ball and rotation), and additional analysis was made from third position for assessment of ball trajectory of independent movement to the rim and maximal height of ball flight from the ground. The kinematic parameters were determined: the angle between the forearm and upper arm (the elbow joint) in three positions (the first, second and the third position), along with the time needed to perform the shooting technique and the ball flight to the rim of the basket with points of intersection in two positions of the body (the second and the third), the angle of ball release (the ball trajectory in relation to the horizontal line), angular velocity of the elbow joint and wrist in two positions (the second and the third), and the height of the ball in relation to the surface in all three positions, both in the case of successful and unsuccessful shots made by the participants.

Even if there is not data about optimal range of kinematic parameters of successful and unsuccessful shots of wheelchair basketball players for each class, there is a few data from study Malone et al. (1999), that we used like reference points in our research.

Results

The pilot study results are shown in table 1 based on the class of disability of the participants and the kinematic parameters of the successful and unsuccessful shot. The parameters are shown in three positions: The initial position, the moment of rest (of the angle between) the elbow and arm being used to perform the free throw in the direction of the basket; The release position, the moment when the angle between the forearm and upper arm in the elbow is smallest, prior to the push of the ball towards the basket and any additional increase in the velocity of ball release; The final position, the angle the elbow assumes when the ball is no longer touching the fingertips of the hand and proceeds to move on its own towards the basket.

The participant from class 1 had almost equal parameters of the duration of the performance of the free throw shooting technique for the unsuccessful and successful throw, the angle of the elbow at the initial, 78° or 80°, and final position, 150° and 151°, as well as height of the ball in the initial and final position. The results indicate that in the case of a successful throw, the angular velocity of the wrist and the elbow is smaller in all three positions, with an angle of ball release of 50°, compared to 45°, as well as flight time of the ball to the rim of the basket. In the release position the height of ball release is low, and the elbow joint is smaller, 65° compared to 89°.

For the participant from class 3, almost completely equal parameters of time needed to perform the free throw shooting technique were recorded for the unsuccessful and successful throw, angle of ball release, 50°, and ball flight, and approximately similar values for the angle of the elbow at the initial, 100° and 95°, and the release position, 53° and 51°, as well as height of the ball at the initial and final position. For the successful throw, the parameters of angular velocity of the wrist and elbow joint are smaller in the release position and drastically so in the final position, 8.23 m/s compared to 6.25 m/s. The height of the ball in the release position is lower by more than 5 cm.

For the participant from class 4.5, a different pattern of move-

ment when performing the free throw technique was noted. Both in the case of the successful and unsuccessful throw the angular velocity of the wrist and the elbow increased and decreased in the release position, only to continue to increase until the final position. Identical parameter values were noted for the angle of ball release (45° and 47°), the angle of the elbow during the release and final position, the angular velocity of the wrist in all three positions, and the duration of the performance of the shooting technique and ball flight. For the successful shot, the angle of the elbow joint in the initial position is greater than 92°, compared to 82°, while the angular velocity of the elbow is drastically lower, 2.60 m/s compared to 3.71 m/s. The initial height of ball release is much greater, 99.15 cm compared to 90.70 cm. For the successful shot, the height of the ball in the release and final position is lower by 5 cm (147.88 cm compared to 152.96 cm and 190.86 cm compared to 194.92 cm).

Table 1. Kinematic results of successful and unsuccessful free throw shots of wheelchair basketball players

Category	Ag1	Ag2	Ag3	Ar	Av	Avw2	Avwe3	H1	H2	H3	T2	T3	TT
Unsuccessful 1	78°	89°	150°	45°	3.70m/s	3.05m/s	8.08m/s	76.48cm	123.52cm	164.48cm	633ms	700ms	1566ms
Successful 1	80°	65°	151°	50°	3.59m/s	2.33m/s	7.58m/s	76.49cm	114.40cm	164.49cm	600ms	700ms	1733ms
Unsuccessful 3	100°	53°	150°	50°	5.01m/s	2.76m/s	8.23m/s	75.85cm	127.21cm	178.58cm	233ms	366ms	1400ms
Successful 3	95°	51°	128°	52°	5.01m/s	2.36m/s	6.25m/s	77.89cm	122.11cm	180.71cm	233ms	366ms	1400ms
Unsuccessful 4.5	82°	66°	149°	45°	3.71m/s	0.23m/s	7.26m/s	90.70cm	152.96cm	194.92cm	566ms	733ms	1600ms
Successful 4.5	92°	63°	151°	47°	2.60m/s	0.23m/s	7.27m/s	99.15cm	147.88cm	190.86cm	533ms	700ms	1633ms

Note: Ag1 – the angle of the elbow in the initial position; Ag2 – the angle of the elbow in the release position; Ag3 – the angle of the elbow in the final position; Ar – the angle of ball release; Av – the angular velocity of the elbow; Avw2 – the angular velocity of the wrist from the initial position to the release point; Avwe3 – the angular velocity of the wrist from the release position of the elbow to the moment the ball takes on independent flight; H1 – the height of the bottom curve of the ball in the initial position; H2 – the height of the bottom curve of the ball from the surface in the release position of the elbow; H3 – the height of the lower curve of the ball from the surface in the final position of the elbow; T2 – the duration of the hand movement from the initial position to the release position of the elbow; T3 – the duration of the hand movement from the release position until the final position of the elbow; TT – the time needed to perform the shooting technique with independent ball flight to the rim of the basket.

Discussion

There are very few studies which focus on the kinematic parameters of the free throw in wheelchair basketball (Goosey-Tolfrey et al., 2002; Malone et al., 1995; Malone et al., 1999; Malone et al., 2002; Schwark, Mackenzie, & Sprigings, 2004). The findings of Malone et al. (1999) and Malone et al. (2002) point to the differences in kinematic parameters and also in the performance of the free throw shooting technique among wheelchair basketball players of various classes. In addition, statistically significant differences for successful and unsuccessful throws emerge between different classes of wheelchair basketball players, a finding which is supported by the research results of this pilot study. Players from class 1 have lower elbow joint velocity, lower height of ball release and initial height of holding the ball, as well as a greater angle of ball release, which is supported by the findings of this study. It is more difficult for a player from class 1 to properly perform a movement in the set kinematic framework, as he needs to generate greater force from a smaller number of muscles and achieve better movement control compared to basketball players from upper classes. Malone et al. (2002) cite that greater arm force is needed to compensate for the lack of movement of the torso, which basketball players from upper classes can achieve. Participants from upper classes have displayed negligible differences in kinematic parameters compared to basketball players from class 1 and 2, which indicates that they do not use the advantage that they have in relation to players from class 1 in terms of the greater initial and final height of ball release, as well as greater angles, which have emerged as key kinematic parameters for successful throws (Malone et al., 2002). Similar findings were noted in this pilot study as well. The participant from class 4.5 has a greater initial and final height of ball release, as well as a different pattern for performing the shooting technique compared to the other participants. A different use of the musculature compared to the participants from class 1 and 3 was noted. The latter, as a result of their disability, have to adapt their shooting technique and the kinematic parameters to their current circumstances, while the participant from class 4.5 can perform the shooting technique within a framework which increases the percentage of precision.

Malone et al. (1995) state that athletes from class 1 have a shooting performance technique which is solely based on an individual model, while taking into consideration the small number of seven participants based on which this conclusion was drawn. The kinematic parameters of the height of the ball in the final position during the throw are 156 cm, 166 cm and 188 cm, while those recorded by Malone et al. (1999) were 162 cm, 179 cm and 184 cm for the participants from class 1, 3 and 4, while in the study of Goosey-Tolfrey et al. (2002) the participant from class 1 had a value of 1.57 cm (compared to the results of the pilot study, 164.49 cm, 180.71 cm) and a somewhat greater height of 194.92 cm for the participant from class 4.5. The minimum angle of ball release of 45° was presented as the ideal in the work of Owen (1982), while Malone et al. (1995) determined that the ideal angle is slightly over 50°, which is supported by the findings of this pilot study. Malone et al. (1999) determined that the angles of ball release among wheelchair basketball players from class 1, 3 up to 4 are 59°, 55° and 55°, while in Malone et al. (1995) the values are 50° and 59° for wheelchair basketball players from class 1, while for the remaining participants they were 54° and 64°. These findings indicate greater values compared to the results determined in the pilot study: 50°, 52° and 47°. Malone et al. (2002) noted an angle of ball release of 55° among wheelchair basketball players from class 4 and 4.5 based on 26 analyzed throws. Interestingly enough, Goosey-Tolfrey et al. (2002) did not determine any statistically significant results in the difference for velocity of ball release among players from various classes, which was not the case in this study. It is worth mentioning that seated height among wheelchair basketball players from class 1 is lower compared to that of other wheelchair basketball players upper classes, which is one of the reasons for the lower recorded values. It is also interesting to note that the results of the comparison between wheelchair basketball and stand up basketball players indicate that the height of ball release is on average lower by 40 cm and the velocity of ball release by 0.39 m/s (Schwark et al., 2004). Goosey-Tolfrey et al. (2002) measured the angular velocity of the wrist during ball release for players from class 1, 3 and 4, which ranged from 7.0 m/s to 8.2 m/s, while in the work of Malone et al. (1999) the values ranged

from 6.99 m/s to 7.40 m/s, compared to the results measured in the pilot study which were 6.25 m/s to 8.28 m/s, which falls under the category of generally similar values.

Malone et al. (2002), who studied unsuccessful throws, have noted that most of the mistakes made by players from lower classes include striking the ball against the near rim of the basket, and that at the same time the correction of the throw is reflected in the increase of the angular speed with an increase in the angle of ball release. The other kinematic parameters remain the same, as does the pattern of movement. We can also note an increase in the height of ball release among successful throws. The kinematic parameters for angular velocity of the wrist and the angle of ball release are 7.4 m/s and 53.8°, but if we take Brancazio's criterion of least speed into consideration, they have a value of 7.08 m/s and 51.3° (Schwark et al., 2004). Hamilton & Reinschmidt (1997), taking into consideration the spin of the ball, calculated the kinematic value of the angle of ball release to be 60°, and angular velocity to be 7.7 m/s.

Conclusion

Based on the kinematic data results of the pilot study, we can conclude that wheelchair basketball players from various classes differ when it comes to performing a successful free throw, but that they also have some kinematic parameters in common. The parameters which are within the value range of existing findings originating from biomechanical studies, and have the greatest impact on performing a successful free throw, include: the angular velocity of the throw, the height of ball release during the initial and final position, as well as the angle of ball release. It can be concluded that there are differences in the pattern of performing the free throw shooting technique between players from different classes when it comes to successful and unsuccessful throws. In order for the conclusions to be generally applicable, it is necessary to include a greater number of participants for each class of players, as well as a greater number of successful and unsuccessful throws.

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Conflict of Interest

The authors declare that there is no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Morphological Characteristics and Lung Function of the Pilots of Montenegro Army

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Abstract

The results of numerous medical studies and kinesiology research show the existence of differences in the lung function with reference to age, body height and the ratio of certain parameters of body composition. The aim of this research is to determine the status of morphological characteristics and the lung function with the pilots of Montenegro Army. The sample of examinees consisted of 30 military pilots of the age 36.3±11. The sample of measures was made of 4 indicators for the assessment of longitudinal dimension, transverse dimension, body mass and volume, subcutaneous fat, body composition and lung function. Central and dispersion variables parameters were calculated. The specificities of the body height of pilots as well as the excessiveness in their body weight were calculated, while the parameters of lung volumes and capacities and the parameters of the flow of respiratory passageways have shown the satisfactory condition of their respiratory function. In addition, it was shown that the pilots are soldiers without individual medical risks in the sense of obesity appearance or obstructive ventilation disturbances. The obtained results indicate the need to conduct research in which the effect of certain morphological measures and parameters of the pilot's body composition to their lung function would be dominantly studied. In that way we would obtain significant data both for the military organisation in the sense of promoting the training system and realization of target tasks, and for the kinesiology science from the aspect of determining certain regularities of the functioning of human body in specific life and work conditions in the army.

Keywords: *Morphological characteristics, Pulmonary function, Soldiers, Pilots*

Uvod

Antropometrijske mjere predstavljaju značajne karakteristike čovjeka na čiji razvoj utiču spoljašnji faktori, teritorijalne i geografske oblasti određene populacije, kao i unutrašnji genetski faktori (Popović, 2017). Plućni volumeni i kapaciteti kao segment funkcionalnih sposobnosti organizma, imaju veliki uticaj na niz značajnih sukcesivno povezanih procesa, kao što su: ventilacija pluća, difuzija gasova i njihovo prenošenje, razmjena gasova između krvi i tkiva i potrošnja kiseonika u ćelijama uz izdvajanje CO_2 (Davidović i sar., 1975).

Prilikom selekcije regruta i potencijalnih kadeta, kao i tokom obuke, analiza morfološkog statusa nam govori da je problem sa prekomjernom težinom i viškom masnog tkiva prilično aktuelan (Craword i sar., 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, 2008). Funkcionalna dijagnostika omogućava uvid u pojedine fiziološke i biohemijske karakteristike organizma čovjeka. Za procjenu strukturalno funkcionalnih karakteristika respiracijskog sustava, 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 medicine (Kaur, Subhedar, Dave, Mishra, & Sharma, 2015).

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Zdravstveni status pilota Vojske Crne Gore (VCG) i njihove profesionalne sposobnosti moraju biti na zavidnom nivou. Proglasiti pilota zdravim prema kriterijumu odsustva bolesti pogubno je i neodgovorno. Zdrav ne može biti nijedan pilot koji nije u stanju, zahvaljujući svojim antropološkim sposobnostima i karakteristikama obavljati svakodnevne ili vanredne zadatke pod povećanim opterećenjem i povećanim zahtjevima na kompletan antropološki status organizma. Zdravlje pilota treba definisati i visokim ili optimalnim stanjem funkcionalnih i motoričkih sposobnosti kao i poželjnim morfološkim proporcijama tjelesnog sastava (Banjević, 2012).

U njegovom istorijskom istraživanju, John Hutchinson (pronalazač spirometra) je utvrdio da su godište i visina najvažnije odrednice funkcije pluća i od tada su mnoga istraživanja potvrdila da se funkcija pluća povećava sa visinom i umanjuje sa godinama starosti (American Thoracis Society, 1991). Starenje rezultira smanjenjem plućne funkcije i povećevanjem tjelesnih masnoća (Wiswell, Hawkins, Jaque, 2001). Neka od istraživanja razmatrala su veličinu ili regionalnu distribuciju FM (masa tjelesnih masti) i FFM (bezmasna masa) u odnosu na funkciju pluća. Po pitanju veličine, za FM je uočeno da se negativno povezuje sa funkcijom pluća, posebno kod veoma gojaznih osoba, dok se pozitivno povezuje za FFM (De Lorenzo i sar., 2001). Po pitanju distribucije za centralni ili gornji dio tijela, uočeno je da se FM negativno povezuje sa funkcijom pluća kod starijih osoba. Pored toga, rezultati su su pokazali da FVC (forsirani vitalni kapacitet) i FEV1 (forsirani ekspiracijski volume u prvoj sekundi) imaju značajno niže vrijednosti kod osoba sa koeficijentom struka i kukova (W/H) većim od ili jednakim 0.95 (tj. FM distribucije gornjeg dijela tijela), u poredjenju sa osobama sa W/H koji imaju manje od 0.95 (FM distribucija donjeg dijela tijela) (Collins, Hoberty, Walker, Fletcher, & Peiris, 1995). Harik-Khan, Wise, & Fleg (2001), su proučavali uticaj W/H na FEV 1 i FVC u istraživanju veće populacije (oko 1500 osoba). Nakon uzimanja u obzir BMI i ostalih varijabli, potvrdili su jaku obrnutu vezu izmedju W/H i FEV1 kod muškaraca, ali ne i kod žena. Osim toga, ustanovljeno je da je veći W/H povezan sa većim redukcijama u FVC medju muškarcima u poredjenju sa ženama. Stoga, direktni efekti distribucije tjelesne masti na funkciju pluća izgledaju izraženiji medju muškarcima. FM skladišten u trbušnoj duplji najvjerovatnije direktno sprečava spuštanje dijafragme, povećavajući težinu na zidove grudnog koša i vodeći do restriktivnog respirativnog poremećaja, kako se navodi u ovoj studiji. Ovakvi deficiti su značajan limitirajući faktor za pripadnike vojne službe, u smislu efikasnosti obavljanja profesionalnih specijalnosti, koje zavise od mnoštva spoljnih faktora (Wiswell i sar., 2001). Slične promjene su zastupljene i u ostalim segmentima tjelesne kompozicije i rezultat su, ne samo uticaja specifičnosti zahtjevnog vojnog poziva, već prevashodno fizioloških i morfoloških promjena povezanih sa biološkim starenjem (Sharp, Knapik, & Wallker, 2008).

Na osnovu navedenih istraživanja, utvrđeno je da se javljaju određene posebnosti u morfološkim karakteristikama i plućnim volumenima i kapacitetima kod ljudi različitog pola i godina starosti. S obzirom na činjenicu da vazduhoplovstvo predstavlja zaseban sistem sa spektrom djelovanja raznovrsnih faktora, postavljen je i cilj ovog istraživanja. On podrazumijeva utvrđivanje stanja morfoloških karakteristika i plućne funkcije pilota VCG. Ostvarivanjem postavljenog cilja, ukazaće se na eventualne specifike, a u praktičnom smislu će se dobiti povratne informacije bitne sa aspekta konstrukcije djelotvornih trenažnih transformacionih procesa.

Metod

U pogledu vremenske određenosti istraživanje je transverzalnog karaktera, a sastoji se u jednokratnom mjerenju odgovarajućih morfoloških pokazatelja i parametara plućne funkcije pilota VCG.

Uzorak ispitanika

Uzorak ispitanika sačinjavalo je 30 pilota Vojske Crne Gore, starosne dobi 36.3±11 godina.

Uzorak mjera

Procjena morfoloških karakteristika izvršena je na osnovu mjerenja, izračunavanja i analize sljedećih antropometrijskih pokazatelja: visina tijela, dužina ruke, dužina noge, dužina stopala, širina ramena, širina kukova, širina stopala, dijametar koljena, masa tijela, srednji obim grudnog koša, obim struka, obim kukova, kožni nabor nadlaktice, kožni nabor trbuha, kožni nabor grudi, kožni nabor natkoljenice, indeks tjelesne mase, gustina tijela, procenat tjelesnih masti i koeficijent odnosa struka i kukova. Mjerenje morfoloških karakteristika je izvedeno u skladu sa Protokolom za morfološku dijagnostiku vojnika (Jukić i sar., 2008), dok je izračunavanje parametara tjelesne kompozicije izvršeno prema protokolima datim u Priručniku fizičke forme povezane sa zdravljem (Kaminsky, 2013).

Procjena plućne funkcije izvršena je na osnovu analize spirometrijskih pokazatelja: forsiranog vitalnog kapaciteta (FVC), forsiranog ekspiracijskog volumena u 1 sekundi (FEV1), odnosa forsiranog ekspiracijskog volumena u 1 sekundi i forsiranog vitalnog kapaciteta (FEV1/FVC) i vršnog izdisajnog protoka (PEF). Spirometrisko testiranje je izvedeno u skladu sa Protokolom za funkcionalnu dijagnostiku vojnika (Jukić i sar., 2008). Za mjerenje parametara plućne funkcije korišćen je spirometar marke (Spirometrics SMI 3) sa pripadajućom programskom podrškom QUARK b^2.

Metode obrade podataka

Dobijeni rezultati su najprije uređeni, a zatim statistički obrađeni na personalnom računaru pod softverskim statističkim paketom SPSS 20.0. Za sve primijenjene pokazatelje morfološkog statusa i plućne funkcije izračunati su deskriptivni statistički parametri centralne tendencije i mjera varijabiliteta: aritmetička sredina, standardna devijacija, minimalni rezultat mjerenja, maksimalni rezultat mjerenja, varijaciona širina, koeficijent varijacije i standardna greška aritmetičke sredine. Testiranje normaliteta raspodjele frekvencija primijenjenih varijabli izvršeno je pomoću standardizovanog koeficijenta asimetrije i standardizovanog koeficijenta izduženosti ili spljoštenosti.

Rezultati

U tabeli 1 prikazani su osnovni statistički deskriptivni parametri morfoloških karakteristika i plućne funkcije pilota Vojske Crne Gore.

Analizom tabele 1, uvidom u vrijednosti standardizovanog koeficijenta asimetrije (skjunis-Sk), koji omogućava da se testira saglasnost empirijskih podataka sa teorijskom Gausovom raspodjelom vjerovatnoće varijabli, može se uočiti da je većina vrijednosti daleko od kritične. Odstupanja se bilježe kod četiri pokazatelja, i to kod dužine noge u pravcu negativne asimetrije gdje dominiraju rezultati sa višim vrijednostima, dok se kod kožnog nabora grudi, kožnog nabora trbuha i gustine tijela, zapaža pozitivna asimetrija sa izraženijim slabijim rezultatima. Pregledom izračunatih vrijednosti standardizovanog koeficijenta izduženosti ili spljoštenosti kurtozisa (Ku), zapaža se da one kod većine primijenjenih morfoloških i funkcionalnih pokazatelja ne prelaze (ili statistički beznačajno čine) kritičnu vrijednost. To znači da se njihova kriva ne razlikuje statistički značajno vertikalno od normalne, teorijske distribucije. Iznimak predstavljaju mjere gustina tijela (Ku=29.82), dužina noge (Ku=8.54) i kožni nabor trbuha (Ku=6.08), gdje se rezultati koncentrišu bliže centralnim vrijednostima, odnosno kriva je uža i sa oštrijim vrhom. To ukazuje da su rezultati međusobno bliski i da se radi o izrazitoj leptokurtič-

Tabela 1. Centralni i disperzioni parametri morfoloških karakteristika i plućne funkcije pilota VCG

Varijable	Min	Max	VŠ	M	Se	SD	KV	Sk	Ku
Visina tijela	170.7	186.8	16.1	180.2	.809	4.43	0.02	-.35	-.56
Dužina ruke	74.5	85.2	10.7	79.7	.474	2.60	0.03	.03	.19
Dužina noge	80.1	109.5	29.4	103.6	1.06	5.84	0.05	-2.47	8.54
Dužina stopala	25.2	29.7	4.5	26.6	.193	1.05	0.03	.98	1.09
Širina ramena	40.4	51.5	11.1	44.6	.397	2.17	0.04	.90	2.52
Širina kukova	29.4	36.1	6.7	32.2	.292	1.60	0.04	.14	-.39
Širina stopala	8.7	10.7	2.0	9.4	.088	.485	0.05	.87	.41
Dijametar koljena	8.0	10.9	2.9	9.5	.162	.891	0.09	-.43	-1.11
Masa tijela	70.0	109.0	39.0	88.5	1.62	8.89	0.10	.22	.16
Obim struka	80.3	108.0	27.7	93.6	1.21	6.64	0.07	.38	.15
Obim kukova	81.2	103.0	21.8	92.0	.854	4.68	0.05	-.10	.29
Obim grudnog koša	94.2	119.1	24.9	104.8	1.03	5.66	0.05	.43	.32
Kožni nabor trbuha	12	60	48	25.2	1.68	9.20	0.36	1.97	6.08
Kožni nabor grudi	3	9	6	5.1	.281	1.53	0.30	1.15	1.34
Kožni nabor natkoljena	3	14	11	7.1	.560	3.06	0.43	.51	-.80
Kožni nabor nadlakta	4	14	10	8.5	.498	2.72	0.32	-.05	-.70
Indeks tjelesne mase	22.36	33.94	11.58	27.40	.498	2.73	0.09	.38	-.29
Gustina tijela	1.04	1.97	.93	1.09	.030	.165	0.15	5.45	29.82
Procenat tjelesnih masti	7.38	21.85	14.47	12.08	.584	3.20	0.26	.99	1.72
Koefic. struka i kukova	.93	1.11	.18	1.01	.007	.039	0.03	.48	.76
FVC	3.37	6.53	3.16	5.08	.123	.677	0.13	-.28	.43
FEV1	3.12	5.04	1.92	4.21	.087	.478	0.11	-.28	.16
FEF	70.6	95.9	25.3	83.41	1.27	6.97	0.08	-.26	-.90
PEF	5.0	12.5	7.5	9.29	.410	2.24	0.24	.42	-.91

Legenda: Min – minimalan rezultat; Max – maksimalan rezultat; VŠ – varijaciona širina; M – aritmetička sredina; Se – standardna greška aritmetičke sredine; SD – standardna devijacija; KV – koeficijent varijacije; Sk – Skwness (koeficijent nagnutosti); Ku – Kurtosis (koeficijent zakrivljenosti); FVC – forsirani vitalni kapacitet; FEV1 – forsirani ekspiracijski volumen u 1 sekundi; FEF – odnos forsiranog ekspiracijskog volumena u 1 sekundi i forsiranog vitalnog kapaciteta; PEF – vršni izdisajni protok.

nosti. Uvidom u dobijene vrijednosti aritmetičke sredine (M), zaključuje se da one egzistiraju u polju prosječnih ili srednjih vrijednosti kod većine primijenjenih varijabli. Inspekcijom varijacione širine primjećuje se da vrijednosti ove mjere ukazuju na neznatne razlike u diskriminativnosti, budući da je u dobijenim rasponima evidentna blaga varijacija broja standardnih devijacija. Dobijene vrijednosti standardne devijacije kod većine morfoloških i funkcionalnih mjera su relativno male i srednje vrijednosti, što govori o manjem i prosječnom odstupanju apsolutnih frekvencija od aritmetičke sredine, te znatnijem grupisanju vrijednosti pokazatelja oko nje. Morfološka obilježja čije vrijednosti standardne devijacije iznose više od jedne trećine aritmetičke sredine su pokazatelji potkožnog masnog tkiva: kožni nabor trbuha i kožni nabor natkoljenice. Kod istih se utvrđuje da većina originalnih skorova nije grupisana na minimalnom odstojanju od centralnih vrijednosti ovih testova. Analizirajući koeficijent varijacije (KV), može se primijetiti da izrazita homogenost postoji kod većine morfoloških pokazatelja, što znači da je u istima i najmanje variranje rezultata. Ovdje se vrijednosti koeficijenta varijacije kreću od KV=0.02 kod visine tijela do KV=0.43 kod kožnog nabora natkoljenice. Međutim, većina primijenjenih mjera se nalazi u rasponu vrijednosti koje označavaju izrazito homogen i homogen skup.

Dobijene vrijednosti standardne greške ocjene aritmetičke sredine skupa, pokazala su manja raspršenja, jer su, gledajući proporcionalno, neznatne u odnosu na odgovarajuće vrijednosti standardne devijacije. Samim tim, može se imati sigurnost u aritmetičku sredinu uzorka kao opravdanu statističku ocjenu populacije.

Diskusija

Piloti VCG u odonosu na prosječnu tjelesnu visinu od 180.2 cm, a prema važećim normativima u vojsci (Generalštab VCG, 1995), prelaze gornju granicu dozvoljene tjelesne težine za 0.5 kg. U odnosu na rezultate studije (Banjević, 2012) gdje su takođe vršena morfološka ispitivanja pilota VCG, konstatuje se prirast tjelesne visine za 1.6 cm. Međutim, interesantno je da je tjelesna visina pilota u oba slučaja primjerena normativima Vazduhoplovnih vojnih snaga. Naime, kod pilota tjelesna visina mora biti u skladu sa određenim propisima zbog same dimenzionalnosti kokpita vazduhoplova, gdje se ciljano misli na sjedeću visinu koja ne smije prelaziti određene norme u odnosu na tip sjedišta letjelice. To se prevashodno odnosi na vazduhoplove koji posjeduju funkciju katapultiranja pilota, kako u tim okolnostima ne bi došlo do njegovog povrijeđivanja u cervikalnom dijelu kičmenog stuba (Stevanović & Jovelić, 2000). Piloti helikoptera tokom leta moraju imati preciznu kontrolu ciklične palice, koja je direktno ispred sjedišta, kolektivne palice sa lijeve strane i dvije pedale nožnih komandi. Položaj koji se pilotu pri tome nameće podrazumijeva naginjanje u naprijed, sa semirotacijom trupa i naziva se helikopterska povijenost. Zbog toga je potrebno da budu ispunjeni standardi za du-

žinu nogu, kako bi pilot helikoptera imao optimalne mogućnosti upravljanja na komandama sa donjim ekstremitetima (Leusden, Prendergast, & Gray, 1991). Zanimljivo je poređenje pojedinih morfoloških parametara pilota VCG sa pilotima Hrvatskih oružanih snaga (Jukić i sar., 2008), budući da imaju identičnu tjelesnu visinu i dužinu stopala (tabela 2).

Tabela 2. Poređenje morfoloških pokazatelja pilota VCG i pilota Hrvatskih oružanih snaga

Morfološki pokazatelji	Piloti VCG	Piloti HOS	Razlika/u korist
Dužina ruke	79.7	78.0	1.7/VCG
Dužina noge	103.6	101.8	1.8/VCG
Dijametar koljena	9.5	9.7	0.2/HOS
Masa tijela	88.5	82.5	6.0/VCG
Obim struka	93.6	90.2	3.4/VCG
Obim grudnog koša	104.8	98.6	6.2/VCG
Kožni nabor trbuha	25.2	25.7	0.5/HOS

Kao što se vidi iz tabelarnog prikaza najveće razlike u korist pilota VCG su u srednjem obimu grudnog koša i tjelesnoj masi. Iako piloti VCG imaju znatno veći obim grudnog koša, vrijednosti pokazatelja njihove plućne funkcije su niži prema sljedećem: forsirani vitalni kapacitet za 0.85 l, odnosno forsirani ekspiracijski volumen u 1 sekundi za 0.44 l. Ipak, vrijednost vitalnog kapaciteta pilota VCG se nalazi u dozvoljenim graničnim vrijednostima za ovu kategoriju vojnika (Komanda ratnog vazduhoplovstva i protivvazdušne odbrane, 1975). Takođe, sam odnos forsiranog ekspiracijskog volumena u 1 sekundi i forsiranog vitalnog kapaciteta (83.41%), ukazuje da se radi o osobama sa dobrom respiratornom funkcijom. Na osnovu toga bi se posredno moglo zaključiti da piloti imaju zadovoljavajući nivo aerobnih kapaciteta organizma. Ipak, za sigurnije određivanje navedene sposobnosti bi se morali primijeniti testovi direktne procjene. Postoje tri razloga zbog kojih bi bilo potrebno što tačnije utvrditi nivo aerobne sposobnosti pilota. Prvi razlog se odnosi na činjenicu da je maksimalna potrošnja kiseonika (VO_2 max) koja bi se uzela kao glavni parametar u procjeni aerobne sposobnosti pilota, prihvaćena kao internacionalni standard za fizičku radnu sposobnost, jer odražava funkcionalnu sposobnost respiratornog, kardiovaskularnog i mišićnog sistema (Životić-Vanović, 1997). Drugi razlog se direktno odnosi na kondicione potencijale kao elemente borbene gotovosti: odgovarajući nivo aerobne sposobnosti je neophodan za uspješno obavljanje zadataka pilota i osnovni je preduslov za izradu efikasnih trenažnih programa usmjerenih ka poboljšanju njihove fizičke pripremljenosti (Banjević, 2012). Treći razlog se odnosi na to da zahtjevi za dovoljno visokim nivoom aerobne sposobnosti, u novije vrijeme sve više imaju zdravstveni značaj (Blair i sar., 1996).

Kada je riječ o indeksu tjelesne mase (BMI), u odnosu na normative (Kristoforović-Ilić, 2000), piloti VCG se svrstavaju u populaciju sa prekomjernom tjelesnom težinom. Međutim, na osnovu klasifikacije prema procentu masnog tkiva (Body fat %) Kuperovog instututa (Kaminsky, 2013), istim ispitanicima se dodjeljuje opisna ocjena vrlo dobro. Dakle, evidentno postoji neusaglašenost pokazatelja nutritivnog statusa, tako da se može tvrditi da višak tjelesne mase nije nastao na račun balastnog masnog tkiva, već drugih parametara tjelesne kompozicije koji nijesu bili obuhvaćeni ovim istraživanjem. Kada su u pitanju individualni zdravstveni rizici kod pilota VCG, prema ispitanim frekvencijama varijabli obim struka i odnos forsiranog ekspiracijskog volumena u 1 sekundi i forsiranog vitalnog kapaciteta, a na osnovu klasifikacije rizika od bolesti (Kaminsky, 2013), došlo se do podataka koji su prikazani u tabeli 3.

Tabela 3. Individualni zdravstveni rizici za nastanak bolesti kod pilota VCG

Obim struka (AOSTR)				Odnos FEV1/FVC			
Rizik nastanka gojaznosti				Opstrukcija respiratorne funkcije			
Povišen	Visok	Irazito visok	Ekstr. visok	Blago	Umjereno	Ozbiljno	Veoma ozbiljno
-	-	-	-	-	-	-	-

Kako se vidi iz tabele 3, piloti VCG su bez individualnih zdravstvenih rizika. Ovo potvrđuje da se radi o zdravoj populaciji, pri čemu je njihov zdravstveni status konstantno predmet medicinskih obrada i posmatranja, koje se vrše sistematski godišnje i periodično u okviru svake pripreme za realizaciju letjenja. Takođe, ovdje treba dodati i izgrađen pozitivan odnos prema bavljenju fizičkim aktivnostima kod ovih pripadnika VCG. Poznato je da dobri kondicioni potencijali doprinose opštem stanju zdravlja i naravno povećanju tolerancije na visinu i druga letačka naprezanja (Komanda ratnog vazduhoplovstva i protivvazdušne odbrane, 1977). Pilot koji je fizički aktivan i bavi se sportom, imaće efikasnije srce, efikasnija pluća i vjerovatno neće biti gojazan. Na taj način on će izbjeći ili bar odložiti srčane napade, hronični bronhitis sa emfizemom i visok krvni pritisak, tri najčešća i najviše onesposobljavajuća oboljenja za letače (Komanda ratnog vazduhoplovstva i protivvazdušne odbrane, 1975).

U skladu sa dobijenim rezultatima, moguće je izvesti sljedeće zaključke: utvrđene su specifičnosti tjelesne visine pilota kao jednog od bitnih preduslova za bavljenje ovim pozivom; prekomjernost u tjelesnoj težini pilota je nastupila na račun segmenata tjelesne kompozicije koji nijesu tretirani u ovom istraživanju; parametri plućne funkcije ukazuju na zadovoljavajuće stanje respiratorne funkcije sa mogućnošću dodatnog razvijanja iste, pa se na osnovu toga daje preporuka za direktnom procjenom aerobnih kapaciteta organizma pilota; došlo se do saznanja da su piloti bez individualnih zdravstvenih rizika u smislu nastanka gojaznosti ili opstruktivnih ventilacijskih smetnji pulmonarne funkcije organizma. Ovim je nesumnjivo potvrđeno djelovanje brojnih specifičnih faktora u sistemu obučavanja i realizacije namjenskih zadataka u Vazduhoplovstvu VCG.

Rezultati ovog istraživanja predstavljaju doprinos u pravcu rasvjetljavanja stanja morfoloških karakteristika i plućne funkcije pilota VCG. Značajno bi bilo sprovesti obimniju studiju u kojoj bi se ispitivale morfološke karakteristika i parametri plućne funkcije svih specijalnosti u VCG, kao i njihova međuzavisnost prema

starosnoj dobi vojnika. Ovaj rad ima poseban značaj zbog vrste tretiranog uzorka, što bi se moglo odnositi na izvjestan način i na ograničenja studije u smislu mogućnosti šire primjene dobijenih rezultata. Ipak, uzimajući u obzir veliki značaj vojske kao posebnog dijela društvene zajednice, neupitna je teorijska i praktična vrijednost ovog istraživanja.

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The authors declare that there is no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

BMI and Nutritional Status in Physical Active Population Involved in Recreational Sport

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Abstract

Practice of sport, exercise or recreational physical activity increase the needs of energy and nutrients. Objectives are: 1) to evaluate BMI; 2) to assess the nutritional status; and 3) to test the association between BMI and KIDMED index. The study is realized on a sample of healthy young participants (N=101), aged 18 – 35, that do recreational sport activities such as: football (N=24), basketball (N=16), handball (N=15), volleyball (N=20), tennis (N=10), swimming (N=10) and martial arts (N=9). Body composition: height, weight, and BMI, were measured and calculated according to World Health Organization's manual. A 16-item KIDMED questionnaire was used to assess nutritional status. KIDMED index was calculated after the KIDMED questionnaire was administered to all participants. Spearman's rank correlation coefficient was applied to test the association between BMI and KIDMED index. We have assessed an optimal diet - medium quality, in physically active population that is involved in recreational sport such as: football, basketball, handball, volleyball, tennis, swimming and martial arts, and a normal healthy weight category based on BMI classification criteria of World Health Organization. In addition, we have found a weak positive association between BMI and KIDMED index in physically active population, that was not statistically significant. The outcome of the study indicates that most of the people that are regularly involved in physical activity have a decent nutritional awareness, as a result of the nutritional counseling they get from their coaches. It seems that recreational collective activities and sports, besides allowing people to gain knowledge about healthy eating skills and nutritional habits, also encourage them to bring the required changes in their diets. The impact of physical activity may be a promising area for future promotion of nutrition and health.

Keywords: *Assessment, BMI, KIDMED index, Nutritional status, Recreational sport*

Introduction

Practice of sport, exercise or recreational physical activity (PA) increases the needs of energy and nutrients (Close, Hamilton, Philp, Burke, & Morton, 2016; Meng et al., 2018). Proper nutrition and consuming highly nutritious food can help population that is involved in recreational sport, as well as professional athletes, to achieve their maximum performance, to reduce the risk of injury, and to ensure the best recovery and health (Close et al., 2016). Including food that contains proteins of high quality and bioavailability, a profile of fatty acids very favorable from a cardiovascular point of view, and vitamins and minerals that are involved in energy and protein metabolism - provides defense against oxidative stress and inflammation, as well as ensures cell growth and tissue repair (Sobaler, Vizuete & Ortega, 2017). In addition, Isenmann et al. (2019) demonstrate the importance of adequate protein and carbohydrate intake from foodstuffs following an exercise bout for the facilitation of muscle regeneration while minimizing the inflammatory response.

Adequate nutrition is essential for development and main-

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tenance of a healthy status throughout life, being an important determinant of human health (Gila-Diaz et al., 2020). It is well established that healthy nutrition and physical activity are key lifestyle factors that modulate lifelong health through their ability to improve body composition, musculoskeletal health, and physical and cognitive performance, as well as to prevent metabolic diseases including obesity, diabetes mellitus, and cardiovascular disease across the lifespan (Baranowski, 2004; Koehler & Drenowatz, 2019).

Dietary plans that enhance performance usually include intake of macronutrients, micronutrients, and fluids throughout the day (Volpe, 2006). Carbohydrate loading maximizes muscle glycogen stores prior to exercise, meaning a delayed onset of fatigue and improvement in performance (Beck, Thomson, Swift, & von Hurst, 2015; Gant, Stinear, & Byblow, 2010; Jentjens et al., 2004). Protein consumption prior to and during exercise has been shown to enhance rates of muscle protein synthesis (Koopman et al., 2006; Pennings et al., 2010; Van-Loon, 2014). Fats are source of essential fatty acids that the body cannot produce by itself (Volek, Noakes, & Phinney, 2015). Fats help the body to absorb micronutrients such as: vitamin A, vitamin D, vitamin E and vitamin K, which are fat-soluble, meaning that they can only be absorbed with the help of fats (Beck et al., 2015). Micronutrients play an important role in energy production, hemoglobin synthesis, maintenance of bone health, adequate immune function and protection of body against oxidative damage (Driskell & Wolinsky, 2006; Girgis, Clifton-Bligh, Hamrick, Holick, & Gunton, 2013; Taylor & Camargo, 2011). They assist with synthesis and repair of muscle tissue during recovery from exercise (Driskell & Wolinsky, 2006; Volpe, 2006). The most common micronutrients, i.e. vitamins and minerals found to be of utmost importance in diets of physically active people or recreational athletes, are: B vitamins, vitamin D, calcium, iron, zinc, magnesium, as well as some antioxidants such as: vitamins A, C, and E, β-carotene, and selenium (Lukaski, 2004; Powers, Deruisseau, Quindry, & Hamilton, 2004; Stockton, Mengersen, Paratz, Kandiah, & Bennell, 2011; Woolf & Manore, 2006; Zittermann & Prokop, 2014). The purpose of fluid consumption during exercise is primarily to maintain hydration and thermoregulation, because there is an increased risk of oxidative stress due to dehydration (Hillman et al., 2013). Thus, fluid consumption prior to exercise is recommended, in order to ensure good hydratation during exercise (Sawka et al., 2007). In addition, carefully planned hyperhydration prior exercise, may reset fluid balance, increase fluid retention, and consequently improve heat tolerance (Beck et al., 2015).

One study has found that a planned scientific nutritional strategy consisting of fluid, carbohydrate, sodium, and caffeine, compared with a self-chosen nutritional strategy, helped recreational runners to complete a marathon run faster (Hansen, Emanuelsen, Gertsen, & Sorensen, 2014). In addition, similar study has shown that a nutritional intervention helped trained cyclists to complete a time trial faster (Hottenrott et al., 2012). Whereas training has the greatest potential to increase performance, it has been estimated that consumption of a carbohydrate–electrolyte drink accompanied by relatively low doses of caffeine, may improve a 40 km cycling time trial performance (Jeukendrup & Martin, 2001).

The importance of individualized or personalized dietary plans has recently emerged. Diets and dietary strategies vary according to the individual training program, personal goals, and food preferences as well (Beck et al., 2015; Jeukendrup, 2014).

Health benefits of nutrition and PA were often studied singularly in the past. Nowadays, it is becoming more evident that the integration of nutrition and PA has the potential to produce greater benefits, instead of strategies focusing solely on one or the other (Baranowski et al., 2004; Close et al., 2016; Koehler & Drenowatz, 2019). A lot of studies examine the role of integrated diet and PA on sports performance and health-related outcomes (Bremer & Cairney, 2016; Meng et al., 2018; Robinson et al., 2015; Serra-Majem et al., 2004). Also, healthy dietary choices and sports participation are independently associated with motor competence, as an important contributor to active and healthy lifestyle (Drenowatz, & Greier, 2018).

Obtaining reliable data on nutritional status, and maintaining an adequate food consumption in individuals that do regular sport and PA, seems to be a key factor for performance enhancement, and a necessary tool for health promotion and disease risk prevention (Baranowski 2004; Gila-Diaz et al., 2020; Koehler & Drenowatz, 2019). The role of the 16-item KIDMED questionnaire in nutritional status assessment has been evidenced by numerous studies, since nowadays the Mediterranean diet is considered one of the healthiest and the best sport performance enhancing dietary models (Gila-Diaz et al., 2020). It is a self-administrated questionnaire, which provides information about the usual dietary intake that is time saving, cost-effective and easy to apply (Gila-Diaz et al., 2020; Koksal, Tek, & Pekcan, 2008).

Therefore, the main objectives of this study are: 1) to evaluate BMI; 2) to assess the nutritional status, and 3) to test the association between BMI and KIDMED index in population that is regularly engaged in PA and recreational sport. However, we hypothesised that there will be a negative association between BMI and KIDMED index based on what previous studies have reported (Lydakis et al., 2012; Martin-Calvo, Chavarro, Falbe, Hu, & Field, 2016).

Methods

Participants

The study is realized on a sample of 101 healthy young participants: (N=48) male, and (N=53) female, aged 18-35, that do regular PA and recreational sport activities such as: football (N=24), basketball (N=16), handball (N=15), volleyball (N=20), tennis (N=10), swimming (N=10) and martial arts (N=9). All participants that took part in the study gave a signed consent for their participation.

Instruments

In order to realize the particular aim of the study, we first performed an assessment of body composition: height, weight and BMI. Participants were measured barefoot and wearing light clothes, according to WHO manual (World Health Organization, 2007). Height is measured using a wall mounted stadiometer (SECA SE206). Weight is measured with a calibrated digital scale (TANITA TBF 300). BMI is calculated from height and weight as follows: Weight (kg)/Height(m)^2. The healthy status was evaluated according to WHO (World Health Organization, 2007) manual.

Next, we have applied the KIDMED questionnaire in order to assess the nutritional status (Koksal et al., 2008; Torun & Yildiz, 2013). It is a 16 item questionnaire that was created to estimate the healthy Mediterranean diet in children, young, and adults, based on the principles that sustain Mediterranean dietary patterns (Serra-Majem et al., 2004). KIDMED index was calculated as explained by Torun & Yildiz (2013), with the scores ranging from 0 to 12. Higher score indicates higher adherence to the healthy Mediterranean diet (with a maximum score of 12): a score ≥ 8 indicates high quality diet; a score between 4 and 7 indicates an optimal diet; while a score ≤ 3 reflects very poor diet quality (1). The questionnaire is shown in Figure 1.

KIDMED questionnaire	Scoring
Takes a fruit or fruit juice every day	+1
Has a second fruit every day	+1
Has fresh or cooked vegetables regularly once a day	+1
Has fresh or cooked vegetables more than once a day	+1
Consumes fish regularly (at least 2-3/week)	+1
Goes >1/week to a fast food restaurant (hamburger)	-1
Likes pulses and eats them >1/week	+1
Consumes pasta or rice almost every day (5 or more per week)	+1
Has cereals or grains (bread, etc.) for breakfast	+1
Consumes nuts regularly (at least 2-3/week)	+1
Uses olive oil at home	+1
Skips breakfast	-1
Has a diary product for breakfast (yoghurt, milk, etc.)	+1
Has commercially baked gods or pastries for breakfast	-1
Takes two yoghurts and/or some cheese (40g) daily	+1
Takes sweets and candy several times every day	-1

Note: Participants should mark the statements that are correct for them. KIDMED index: poor ≤ 3; medium 4-7; high ≥ 8;

FIGURE 1. KIDMED questionnaire and Mediterranean Diet Quality Index

Data analysis

SPSS 23 statistical package was used to perform statistical analysis. Normality of data distribution was tested by K-S test, Skewness and Kurtosis values. Appropriate statistical methods were used to calculate descriptive statistical parameters. Spearman's rank correlation coefficient was applied to test the association between BMI and KIDMED index in physically active population involved in recreational sport.

Results

Descriptive statistical parameters are presented in Table 1. According to it, data have a normal distribution, with a normal asymmetry considered when values for Skewness are in range between -1.00 to 1.00, and Kurtosis values between -3.00 to 3.00 (Kallner, 2013; Zeqiri, Stojmanovska, & Georgiev, 2020).

In addition, we present mean average and standard deviation of assessed parameters based on the recreational activity or sport participants have practiced (Table 2).

Figures 2 and 3 represent BMI and KIDMED index in physically active population, respectively. According to WHO (World Health Organization, 2007) BMI classification, physically active population included in the study belongs to the normal weight category, and based on KIDMED index classification, it has an optimal – medium quality diet.

Table 1. Descriptive statistical parameters in physical active population involved in recreational sport

	N (48M & 53F)	Min	Max	Mean	SD	Skewness	Kurtosis	K-S
Age	101	18	35	21.37	5.97	0.85	-0.23	p > .20
Weight (kg)	101	45.00	115.00	71.02	14.53	0.50	-0.50	p > .20
Height (cm)	101	153.00	192.00	175.69	8.53	-0.28	-0.36	p > .20
BMI	101	17.04	31.72	22.83	3.40	0.31	-0.84	p > .20
KIDMED index	101	1	12	7.11	2.41	-0.32	0.06	p > .20

Notes: N-sample size; Min-minimum; Max-maximum; SD-standard deviation; K-S -Kolmogorov-Smirnov test M-male; F-female

Table 2. Mean average and standard deviation in physical active population based on the recreational sport practiced

Type of PA / recreational sport	N	Mean±SD				
		Age	Weight (kg)	Height (cm)	BMI	KIDMED index
football	24	22.83±5.34	69.92±15.50	173.00±0.11	23.16±3.10	5.63±2.28
basketball	16	21.56±5.16	79.31±12.75	179.00±0.06	24.51±2.69	7.56±3.50
handball	15	22.67±6.55	74.13±12.13	175.00±0.07	24.95±3.31	7.93±1.91
volleyball	20	18.75±4.23	69.43±15.89	178.00±0.07	21.73±3.56	7.95±1.43
tennis	10	24.30±7.96	64.10±16.97	172.00±0.09	21.41±4.24	7.90±1.66
swimming	10	22.20±5.41	67.65±11.66	175.00±0.09	21.99±2.72	6.60±1.96
martial arts	9	21±5.57	69.00±12.06	178.00±0.08	21.90±3.66	6.67±2.55

Notes: PA-physical activity; N-sample size; SD-standard deviation

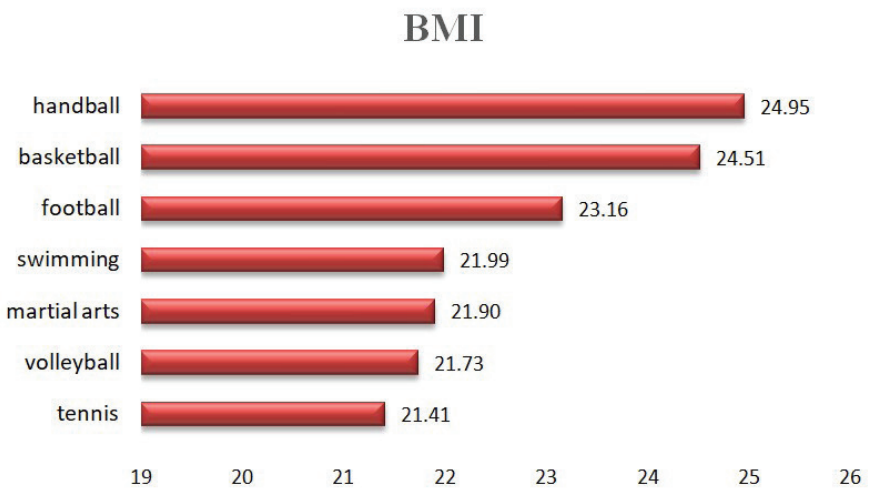

FIGURE 2. BMI of physical active population involved in recreational sport

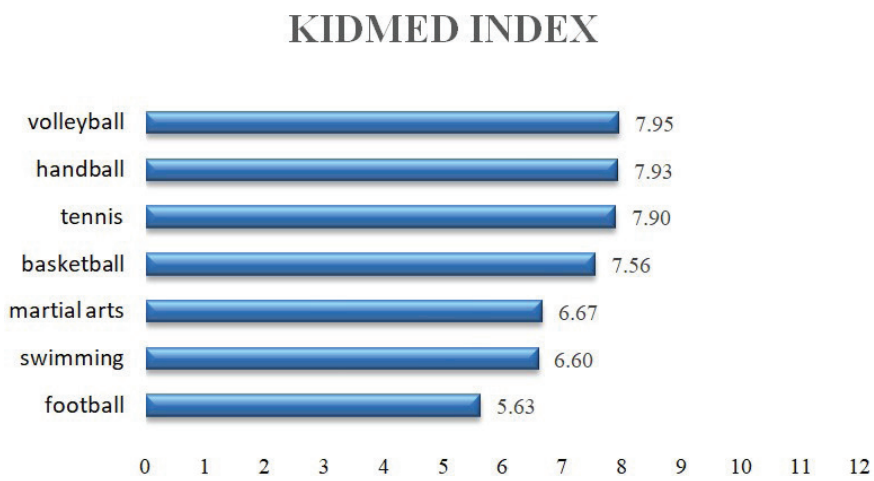

FIGURE 3. KIDMED index in physical active population involved in recreational sport

In Table 3, we present the association between BMI and KIDMED index in physically active population that do recreational sport. Spearman's rank correlation coefficient (ρ = 0.36) shows a weak positive association that was not statistically significant (p=3.91).

Table 3. BMI and KIDMED index association in physical active population involved in recreational sport

Spearman's ρ correlation coefficient	BMI	KIDMED index
BMI	1	0,36
KIDMED index	0,36	1
p-value = 3,91		

Discussion

Based on what is shown in Table 2 and Figure 2, participants that played basketball and handball in recreational way, have higher BMI than participants that play football, volleyball and tennis, or participants that do swimming and martial arts. Since BMI is not able to differ between body fat % and muscle mass % (Shukova-Stojmanosvka, 2009), we are limited to do strong conclusions, but we may point out the possible directions. Higher BMI in amateur/recreational basketball and handball players might be a consequence of a higher body fat percentage, or also a higher muscle mass percentage, since it is reported that basketball and handball players have bigger percentage of muscle mass than players from other sports due to the "greater contact" in between (Silva, Petroski, & Araujo Gaya, 2013). On the other hand, we must take in consideration that our population is not professional athletes like in the study of Silva et al. (2013) that train 6 times per week. Amateur/recreational athletes train 3-4 times per week only (Volpe, 2006), while it is reported that training frequency is an important factor that affects the hypertrophic response (Dankel et al., 2017). Opposing to this, a recent review has reported a strong evidence that training frequency does not significantly impact muscle hypertrophy (Schoenfeld, Grgic, & Krieger, 2018). Taking everything into consideration, we acknowledge the lack of body fat and muscle mass percentage (%) parameters following BMI, as a major limitation in this study. The inclusion of above mentioned parameters in addition to BMI seems necessary to discuss the present topic. Also, we must point out that the heterogeneity of the sample in terms of sex is another important limitation.

According to Table 2 and Figure 3 physically active population included in the study has an optimal – medium quality di-

et according to KIDMED index classification (Torun & Yildiz, 2013). This indicates to a moderate level of awareness about the importance of increased energy expenditure due to physical activity, and the nutritional factor in the process of muscle regeneration, anabolism and lean body mass increase, between physically active population, and recreational/amateur athletes.

Lowest value for the KIDMED index is presented in physically active population that plays recreational football (Figure 3). Football is a highly demanding game in which players are subjected to numerous actions that require overall strength and power production, speed, agility, balance, stability, flexibility, and the adequate level of endurance (Jovanovic, Sporis, Omrcen, & Fiorentini, 2011). Therefore, recreational/amateur players and people that play football regularly should be very cautious with the nutritional intake. Actions involved in football require muscle glycogen to produce ATP, thus the carbohydrate need of football players (even recreational/amateur ones) should be higher (6 - 10 g/kgBW) (El Gezrey & Abdelhaliem, 2018).

Recreational/amateur football players should be aware that low carb diet could limit regeneration of adenosine triphosphate (ATP) and limit the muscles' ability to contract with high force (El Gezrey & Abdelhaliem, 2018). Consumption of a carbohydrate meal solution after training enhances the rate of muscle glycogen repletion (Beck et al., 2015). Usually, 6 hours after exercise, carbohydrate stores are replenished for about 60-70%, but while consuming a carbohydrate meal after a workout session, carbohydrate stores can be replenished up to 90% (Beck et al., 2015; Knuiman, Hopman, & Mensink, 2015).

People who exercise regularly must be aware of the fact that attaining a proper nutrition and an adequate energy intake is a key factor for enhancing the sports performance, as well as sustaining a good physical appearance (Volpe, 2006). Increasing the protein intake by adding a liquid protein meal supplement to the diet may be also considered, since protein requirement for growth of lean muscle tissue is greater than the one for maintenance, possibly in the range of 1.5 to 1.8 g/kgBW (Benardot, 2006; Clark 2000).

In order to accurately assess energy requirements for recreational athletes or people that are regularly involved in PA - training volume, frequency, and intensity must be considered (Hills, Mokhtar, & Byrne, 2014). In general, it is recommended a dietary protein intake to be 1.5–1.8 g/kgBW (max. 2.2 g/kgBW) with a focus on sufficient protein at each meal (0.40–0.55 g/kg/meal) and an even distribution throughout the day (Shukova-Stojmanovska, 2014; Volpe, 2006). Further, minor benefits can be gained by consuming protein in close proximity to training sessions (1–2 hours pre-exercise and within 1–2 hours post-exercise) (Shukova-Stojmanovska, 2009; Pennings et al., 2010). Amino acids, especially essential amino acids stimulate the process of muscle protein synthesis (Beck et al., 2015; Koopman et al., 2006). While all amino acids provide the necessary "building blocks" for the synthesis of new tissue, the amino acid leucine is especially important as a "metabolic trigger" of muscle protein synthesis (Beck et al., 2015). Thus, a sufficient concentration of leucine is necessary to reach a "leucine threshold" which is required to maximally stimulate the protein synthesis in a muscle (Koopman et al., 2006).

Based on current evidence, it is reasonable to consume sufficient amounts of carbohydrates when practicing a sport, or when regularly involved in physical exercise, possibly in the range of 6–10 g/kgBW (Bartlett, Hawley, & Morton, 2015; Burke, Hawley, Wong, & Jeukendrup, 2011; Stellingwerff & Cox, 2014). Consuming carbohydrates immediately post-exercise would be a good strategy to maximize rates of muscle glycogen synthesis (Beck et al., 2015; Knuiman et al., 2015). In addition, 2 hours delayed feeding after glycogen-depleting cycling exercise, has reduced glycogen synthesis rates (Beck et al., 2015).

After calories have been devoted to carbohydrates (6–10 g/kgBW) and proteins (1.5–2.2 g/kgBW), the remaining calories should be allotted to fats (Shukova-Stojmanovska, 2014). Dietary fats should be consumed at moderate levels, neither too low nor high (0.8–1.5 g/kg/day), because they are essential nutrients that are involved in many functions in the body (Shukova-Stojmanovska, 2014), including building cell's membrane, absorption of fat-soluble vitamins, hormonal regulation and maintaining testosterone function (Beck et al., 2015; Volek et al., 2015). Fatty acids that might be of significant importance for physically active people and athletes are omega 3 and omega 6 (Shukova-Stojmanovska, 2014).

Also, it is recommended to consume a variety of fruits and vegetables in order to meet micronutrient needs, or to add a multivitamin/mineral supplement to emphasize diet, in order to prevent any micronutrient deficiencies (Girgis et al., 2013; Stockton et al., 2011; Taylor & Camargo, 2011; Zittermann & Prokop, 2014). Creatine (3–5 g/day) and caffeine (5–6 mg/kg) should be considered as well - as they can yield ergogenic effects for athletes (Bufford et al., 2007; Burke, 2008; Burke, Desbrow, & Spriet, 2013; Lane et al, 2013; Spriet, 2014). Beta-alanine (3–5 g/day) and citrulline malate (8 g/day) are dietary supplements that can be considered too, as they may potentially be of benefit for both - recreational and advanced athletes, depending on individual training regimens (Iraki, Fitschen, Espinar, & Helms, 2019). They have performance-enhancing functions such as: increasing the power output and working capacity, and decreasing the feelings of fatigue (Blancquaert, Everaert, & Derave, 2015; Quesnele, Laframboise, Wong, Kim, & Wells, 2014).

Finally, according to Table 3, we have found a weak positive association (ρ=0.36) between BMI and KIDMED index in physically active population, that was not statistically significant (p=3.91). Even though not significat, the direction of the association is opposite to what is reported in literature (Lydakis et al., 2012; Martin-Calvo et al., 2016). However, the targeted populations in previously mentioned studies were not involved in regular sport. We assume that the direction of the association in our results differ to what is previously reported, because of the type of the population sample included in our study. BMI does not differ between fat mass percentage % and muscle mass percentage % (Shukova-Stojmanosvka, 2009). Thus, higher BMI may be a result of a higher % of fat mass, but also may be a result of a higher % of muscle mass when targeting physically active population involved in regular sport. Spenst, Martin, & Drinkwater. (1993) found a statistically significant difference in muscle mass % between people involved in sport and ones that were not physically active, favoring the active ones. Due to this limitation, we are not able to do any further conclusions. However, we propose including additional parameters, such as: body fat % and muscle mass % in addition to BMI, especially when targeting physically active population that is involved in regular sport, in order to present a clearer and a more evident perspective. Another suggestion for future studies would be inclusion of larger sample size with a possibility of age and sex differentiation.

Conclusion

In conclusion, we have assessed an optimal diet of medium quality, in physically active population that is involved in recreational sport such as: football, basketball, handball, volleyball, tennis, swimming and martial arts, and a normal healthy weight category based on BMI classification criteria of World Health Organization (World Health Organization, 2007). We must point out that even if we are talking about recreational athletes in the present study, its outcome indicates that most of the people that do regular exercise have a decent nutritional awareness, as a re-

sult of the nutritional counseling they get from their coaches. It seems that recreational collective activities and sports, besides allowing people to gain knowledge about healthy eating skills and nutritional habits, also encourage them to bring the required changes in their diets. The impact of physical activity may be a promising area for future promotion of nutrition and health. In addition, we have found a weak positive association between BMI and KIDMED index ($\rho = 0.36$) that was not statistically significant ($p=3.91$). We assume this result to be a consequence of the population sample targeted in our study. Thus we propose including body fat % and muscle mass % in addition to BMI when targeting physically active population that is involved in regular sport, in order to get a clearer and a more evident perspective.

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Conflict of interest

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JASPE Journal of Anthropology of Sport and Physical Education

ORIGINAL SCIENTIFIC PAPER

Gender Differences in Physical Activity, Physical Fitness and Well-being of Students During The Lock-Down Due to Covid-19 Pandemic

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Abstract

Restricting movement for the population and the impact of preventative measures due to the COVID-19 pandemic have spurred research interests in analyzing the healthy lifestyle of the student population. The aim of the study was to examine gender differences between students in physical activity, and the perceptions of physical fitness and well-being during lock-down due to COVID-19. The sample consisted of male (n=268; 25.9%; age 22.56±2.12) and female students (n=768; 74.1%; age 22.12±1.73) at the University of Sarajevo (UNSA). The questionnaire included questions and scales constructed to measure: physical activity, physical fitness, and the acute effects on well-being. χ^2 independence test were used to determine gender differences ($p<0.05$). Prior to the declaration of the COVID-19, there was a significant difference in the level of regular physical activity between male and female students at UNSA ($p<.01$). The data indicated that at that time 65% of male students were regularly physically active, while 45% of female students had regular physical activity. During the lock-down measures at UNSA: 46% of male and 40% of female students reported being regularly physically active and no significant differences were found in relation to gender ($p>.05$); 65% of male and 58% of female students reported a decline in physical fitness and significant gender differences were found ($p<.05$). After exercising male students reported better concentration and mood, more energy and motivation, and less nervousness in the range of 62–79%, while female students reported better concentration and mood, more energy and motivation, and less nervousness in the range of 62-81%. No significant differences were found in the physical activity acute effects on students' well-being in relation to gender ($p>.05$). Although gender differences in physical activity disappeared during the early phase of COVID-19 and lockdown measures, a more pronounced decrease in physical fitness was present in female students. The reported physical activity had equally positive acute effects on students' well-being.

Keywords: *Lock-Down, Active Lifestyle, Physical Exercise*

Introduction

Insufficient physical activity is a serious health concern among university students (Irwin, 2004). In different countries, some research has shown that male students were often more physically active than female students (Olfert, et al. 2019; Iglesias López, Cuesta Santa Teresa, & Sáez Crespo, 2014; J. Bergier, B. Bergier, & Tsos, 2016; Bergier et al. 2018). The active lifestyle is a set of behaviors, actions or habits that make a unified whole (Sharkey & Gaskill, 2007). Also, some results indicate that men and women respond differently to PA (Hands, Larkin, Cantell, & Rose, 2016).

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At the start of the COVID-19 pandemic in Bosnia and Herzegovina in March 2020, the entity governments issued an order to close higher education institutions to prevent the spread of the new coronavirus among the student population, while the educational process continued through distance learning. Such restrictive measures of lock-down referred to the ban on group gatherings of people and the closure of all sports or fitness centers, sometimes with full lock-down measures during the weekends which referred to the restriction on leaving home. The COVID-19 pandemic has a strong impact on all aspects of society, including physical and mental health (Holmes et al. 2020; Ahorsu, Imani, Saffari, Griffiths, & Pakpour, 2020). The average level of physical activity in men and women was significantly reduced during the early phase of the Covid-19 pandemic (Atiković et al. 2020). Adverse effects of sedentary behavior can be partially prevented by any reduction in inactivity and increase in physical activity, even below the recommended guidelines, and thus achieve significant health benefits (Hall, Laddu, Phillips, Lavie, & Arena, 2021). The frequency of physical activity is linearly related to the most dimensions of well-being (Peralta et al. 2021).

It can be assumed that collective understanding will develop response to the COVID-19 pandemic, which is in the interest of both personal and social health. In such times of crisis, whether real or perceived, it is also important to point out all the benefits in empowering people to actively maintain their health. At the same time, physical activity, physical fitness and well-being should be in focus. Restricting movement for the population and the impact of preventative measures due to the coronavirus pandemic (COVID-19) have spurred research interests in analyzing the active lifestyle of the student population. The aim of the study was to examine gender differences between students in physical activity, and the perceptions of physical fitness and well-being during lock-down due to COVID-19.

Methods

The sample consisted of male students (n=268; 25.9%; age 22.56±2.12) and female students (n=768; 74.1%; age 22.12±1.73) from the University of Sarajevo (UNSA), Bosnia and Herzegovina. The sample of respondents was selected by random selection. During this research, students attended the I, II and III cycle of studies.

The questionnaire used in the research is the work of professors from the Faculty of Sport and Physical Education, University of Montenegro. It was adapted to the circumstances caused by the COVID-19 pandemic. The questions were related to: the implementation of regular physical activity (in the period before the Covid-19 pandemic and in the period during the lock-down measures); the perception of declining physical fitness, and the perception of well-being after physical exercise during lock-down measures (better concentration, better mood, less nervousness, more energy, and more motivation). The scale of perception was used in the dichotomous format of the answer (the answer "Yes" is scored with 1; "No" with 0). Respondents completed questionnaires using the Google Forms (from May 5th to 24th 2020), and the results were automatically exported to a Google spreadsheet. The link was shared on the website by all faculties of the UNSA. The answers to the questions referred to the period of partial closure in which limited movement was allowed without group gatherings, as well as complete closure sometimes during the weekend, which referred to the restriction of leaving home.

Computer data entry and processing of survey questionnaires was realized using the office program Excel and SPSS 21 (Chicago, IL, USA). The responses are presented in percentage values (%) and in relation to gender. Pearson $\chi 2$ independence test was used to determine gender differences. The level of statistical significance was set at $p<0.05$.

Results

Prior to the declaration of the COVID-19, there was a significant difference in the level of regular physical activity between male and female students at UNSA ($p<.01$). The data indicated that at that time 65% of male students were regularly physically active, while 45% of female students had regular physical activity. During the lock-down measures at UNSA: 46% of male students and 40% of female students reported being regularly physically active and no significant differences were found in relation to gender ($p>.05$); 65% of male students and 58% of female students reported a decline in physical fitness and significant gender differences were found ($p<.05$) (Table 1). After exercising male students reported better concentration and mood, more energy and motivation, and less nervousness in the range of 62–79%, while female students reported better concentration and mood, more energy and motivation, and less nervousness in the range of 62-81%. No significant differences were found in the physical activity acute effects on students' well-being in relation to gender ($p>.05$) (Table 2).

Table 1. Gender differences in regular physical activity and physical fitness of students

	% Male	% Female	χ2	Sig.
I practiced regularly physical activity before COVID-19	65.3	45.4	31.335	.000**
I practiced regularly physical activity during lock-down	46.4	40.5	2.349	.125
I feel a weakening of physical fitness during lock-down	58.1	65.5	4.739	.029*

Legend: % - percentage values; χ2 - Pearson Chi-Square test; Sig. - statistically significant; ** p<0.01; * p<0.05.

Table 2. The perception of well-being during lock-down

After physical activity, I feel more:	% Male students	% Female students	χ2	Sig.
Better concentration	62.6	62.6	3.421	.064
Better mood	77.4	80.8	.038	.846
Less nervousness	78.7	77.9	.563	.453
More energy	65.4	62.1	2.582	.108
More motivation	64.9	64.9	.459	.498

Legend: % - percentage values; χ2 - Pearson Chi-Square test; Sig. - statistically significant; ** p<0.01; * p<0.05.

Discussion

There are legitimate concerns that the health crisis caused by the COVID-19 pandemic could negatively effect on students' physical activity, physical fitness and well-being regardless of gender. The total physical activity in the student population may indicate its reduced level during the crisis period of the COVID-19 pandemic, that

concerned partial closure in which limited movement was allowed without group gatherings, as well as complete closure related to the restrictions on leaving home. It is understandable that the declining trend of physical activity is accompanied by a decline in physical fitness. However, female students appear to have a more pronounced problem with maintaining a sufficient level of physical fitness.

The trend of decreasing physical activity levels during COVID-19 is understandably given that sports and leisure facilities were closed and physical activity were suspended to prevent the spread of the new coronavirus. The early phase of the pandemic and measures to restrict movement were a surprising factor in the lives of students.

There is a reasonable assumption that physical activity may be useful as a protective mechanism against the risk of developing a possible negative well-being during such a crisis. However, such claims need to be further investigated. There is knowledge that moderate-intensity physical exercise improves mental function, which is not the case with high-intensity exercises (Kashihara, Maruyama, Murota, & Nakahara, 2009). It is already known that pandemics can lead to increased stress, anxiety, worry, and paranoia over potential infection (Roy et al. 2020). The same, combined with a sedentary lifestyle and poor eating habits, can become a more serious form of stress that can cause negative changes and thus jeopardize the normal functioning of the human body (Panahi & Tremblay, 2018). Also, sports and physical activities are the most important for combining the problem of weight gain (Montesano & Mazzeo, 2019). Positive acute effects on well-being justify the strong potential of physical activity in various life situations.

In all future similar crisis situations, it is necessary to find alternative ways of acting in the direction of raising the awareness of the student population with the aim of a physically active lifestyle. Given that this research was conducted during a very early phase of movement restrictions, the population certainly found themselves in the conditions of real and perceived danger. Socially responsible institutions tried to make correct but also sometimes very rigorous decisions. In every time of crisis, it is necessary to go through a period of getting used to new living and working conditions. After accepting the new conditions of life and action, adaptation and active action may follow. Specific practical recommendations may be that in similar situations of limited movement, it is important to remain physically active or to become more physically active, which is important regardless of gender.

The limitation of this study was the non-standardized questionnaire, which was improvised due to the urgency of the research in order to be able to respond quickly. Also, information of the type, duration, and intensity of physical activity was not available in this study. In future similar emergencies, it is possible to form a crisis group at the university level, formed by experts in the field of sports and physical education, and which would be ready to respond effectively and offer the best solutions for exercising and maintaining physical fitness.

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Conflict of Interest
The authors declare that there is no conflicts of interest.

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Journal of Anthropology of Sport and Physical Education

SHORT REPORTS

The Correlation between Night Sleep Duration and Physical Activity with Cardiorespiratory Fitness Test Results in Healthy Medical College Students: a Pilot Study

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Abstract

Lack of sleep is the risk factor for a cardiovascular event and low cardiorespiratory endurance. Medical college students are more frequent in experiencing a lack of sleep due to their duty. This study evaluated the correlation between lack of sleep and cardiorespiratory endurance test results in medical college students. This cross-sectional study involved sixty-two males, medical college students. Sleep duration of two weeks was assessed using a validated questionnaire. Queen College Step test was employed for a cardiorespiratory endurance test. Spearman rank test was employed to evaluate the correlation between variables, while logistic regression was applied to assess the possibility of having a good VO_{2max}. SPSS version 19 was used to process the data and perform a statistical test. Significance was set at $p<0.05$. The mean sleep duration was 6.2 hours, with more students having insufficient sleep duration (51 participants). The mean VO_{2max} was 50.4 ml/kg/min, with more students having good VO_{2max} (50 participants). Spearman rank test indicated the weak correlation between age and sleep ($r=0.2$, $p=0.04$) and a moderate correlation between physical activity and VO_{2max} ($r=0.43$, $p<0.01$). No correlation between sleep and VO_{2max} result ($p=0.07$). Logistic regression showed sufficient physical activity is associated with 14.5 times possibility of having good VO_{2max} (95% CI 2.7-77.8, $p=0.02$). The correlation between sleep and the VO_{2max} result was not evident. Instead, sleep was associated with students' age while VO_{2max} with sufficient physical activity.

Keywords: *Cardiorespiratory Fitness, Sleep Deprivation, College Students, Risk of Heart Diseases*

Introduction

Sleep is essential for the proper function of the organ system, including the musculoskeletal (Mental Health Foundation, 2018). Usually, a night sleep duration is 7-9 hours. Sleep duration of fewer than 7 hours is generally considered lacking. Lack of sleep duration is associated with health problems such as obesity, diabetes, hypertension, heart disease and stroke, depression, and even an increased risk of death. A cohort study conducted with a large sample observed that people who have disorders or lack of sleep would have risk factors for heart disease (Garde, Hansen, Holtermann, Gyntelberg, & Suadicani, 2013). Sleep deprivation is associated with a 48% increased risk of coronary heart disease and a 15% increased risk of stroke (Holst, Sousek, & Landolt, 2014). In comparison, sleep duration of more than 9 hours at night is assumed as long sleep. Sleep deprivation is also associated with some disturbances such as mild depression, anxiety, social withdrawal, and death (Patel, Malhotra, Gottlieb, White, & Hu, 2006; Watson, et al., 2015).

There is a high level of stress in medical students due to high academic demands. They spent a lot of their time studying and internship in a hospital with night duty. This causes them to have short-

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er sleep duration and lower participation in exercise. Many students complain of a lack of sleep, sleepiness, sleep deprivation, and learning difficulties during college (Giri, Baviskar, & Phalke, 2013). Sleep deprivation elicits physiological responses such as increased sympathetic activity leading to vasoconstriction, bronchodilation, and increased heart rate, and decreased insulin secretion (Castro-Diehl et al., 2016). If this response occurs chronically, it will disturb many organ functions.

Cardiorespiratory endurance is one of the health-related physical fitness components besides muscle strength & endurance, flexibility, and body composition (Russell, Oria, & Pillsbury, 2012). Cardiorespiratory endurance refers to the capability of the heart and lungs to deliver oxygen to the muscle during activity. Thus, it is a suitable parameter to assess heart and lung function. Cardiovascular risk is associated with low cardiorespiratory endurance (Rodrigues, Perez, Carletti, Bissoli, & Abreu, 2007). Maximum oxygen uptake (VO_{2max}) can measure cardiorespiratory endurance during exercise tests. The VO_{2max} can be yielded using standard methods, either maximal or submaximal tests (American College of Sports Medicine, 2006). The tests could be conducted simply by walking, jogging, running, or bench stepping. The submaximal test is considered a saver for patients, disabled, and unfit people (Gappmaier, 2012; Noonan & Dean, 2000).

Sleep quality and duration can reduce the level of physical activity and disturb the cardiorespiratory endurance test. Antunes et al. investigated the effect of sleep quality and duration on maximal incremental test performance in healthy. They observed that participants with good sleep quality had higher power and cardiorespiratory endurance test and a low maximal heart rate (Antunes et al., 2017). Also, a review article by Kline stated that exercise and sleep have a bidirectional relationship. Exercise could improve sleep disturbance, whereas poor sleep quality lowers physical activity (Kline, 2014). Therefore, this study investigates the correlation between sleep duration, physical activity and endurance tests in medical college students, to determine whether sleep duration and physical activity could influence submaximal endurance test results.

Methods

Participants

The design of this study was a cross-sectional with descriptive-analytic. Sixty-two students participated in the study. Inclusion criteria were set as follows: male students, healthy. Exclusion criteria included taking medication causing drowsiness or sleep, sleep disturbance due to any caution (anxiety, depression, etc.), mobility impairment, physical weakness due to several causes, musculoskeletal disorders affecting lower limbs or respiratory muscles. Participants agreed to participate and gave their informed consent after an explanation. This study was conducted from May to August 2019. The ethics commission of the School of Medicine and Health Sciences, Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia, had approved the study (No: 22/12/KEP-FKUAJ/2019).

Data Retrieval

A questionnaire was employed for primary data, inclusion and exclusion criteria, and sleep behavior. The questionnaire recorded the sleep behavior of participants for two weeks. The questions had been validated. Sleep duration was mean sleep duration for 14 days, obtained from (ten workdays sleep+four weekend sleep)/14. The sleep duration less than 7 hours denoted insufficient while >7 hours denoted normal. Physical activity (PA) is considered 'insufficient' if doing an exercise or sport less than 30 minutes/session three times a week, while 'sufficient' is 30 minutes or more and three times a week.

Measurements

Weight was measured in minimal clothes using a digital scale (Robusta 813, Seca, Germany), expressed in kg. Height was measured in Frankfort position barefoot using a stadiometer, expressed in cm. Body Mass Index (BMI) was obtained from the weight (kg) divided by the square of height (m), presented as kg/m2. Body mass index was normal if BMI <23 kg/m2, and overweight if BMI ≥23 kg/m2 (Hsu, Araneta, Kanaya, Chiang, & Fujimoto, 2015; WHO Expert Consultation, 2004).

Endurance test

Cardiorespiratory endurance (VO_{2max}) was evaluated using the Queen College Step (QCS) test (QCS). This test was conducted by stepping up and down on a bench with a height of 41.3 cm. The bench height was suitable for Asian people. The pace of stepping followed a metronome rhythm, 24 steps for males and 22 steps per minute for females. The participants completed the test for three minutes. The test was considered to fail if the participants finished the test for less than three minutes. Heart rate at the 15th-second pots test was recorded. The VO_{2max} was calculated from heart rate at 15th second post-test us-

Tables 1. Characteristics of the participants

Variables	Mean±SD or frequency (%)
Age (years)	19.5±0.8
Weight (kg)	70.10±11.9
Height (cm)	170.2±5.5
BMI (kg/m^2)	24.2±3.9
Normal/underweight	23 (37.1%)
Overweight/obesity	39 (62.9%)
Sleep duration (hours)	6.2±0.8
Insufficient	51 (82.3%)
Normal	11 (17.7%)
VO_{2max} (ml/kg/min)	50.4±6.1
Low	12 (19.4%)
Good	50 (80.6%)
Physical activity	
Insufficient	37 (59.7%)
Sufficient	25 (40.3%)

Note. BMI - Body mass index; VO2 max - Maximal oxygen volume

ing equations (for male: VO_{2max} (ml/kg/min) = 111.33 - (0.42 x heart rate (bpm), for female: VO_{2max}(ml/kg/min) = 65.81 - (0.1847 x heart rate) (MacKenzie, 2001). The post-test heart rate was monitored using a heart rate monitor from the smartwatch (Mi Band 3, Xiaomi, China). The test was considered valid to predict maximum oxygen uptake (Chatterjee, Chatterjee, Mukherjee, & Bandyopadhyay, 2004). Participants wore sports clothes during the QCS test. The test was conducted in the morning before the class to ensure the students were still fresh.

Statistical analysis

The numerical data were presented as mean values with standard deviation while categorical data as frequency and percentage. The correlation between VO_{2max} and relating factors was evaluated using the Spearman rank test, while the logistic regression was applied to estimate the possibility of several influencing factors toward VO_{2max}. The significance level was determined at $p<0.05$. The statistical analysis was analyzed using SPSS 19 program.

Results

The characteristics of the participants are presented in Table 1. The mean BMI of the participants exceeded the normal BMI. There were more students with overweight or obesity than normal/underweight (62.9% vs. 37.1%). The mean sleep duration indicates less than normal (< 7 hours). This was confirmed in which there were many more students with a lack of sleep (82.3% vs. 17.7%). Most students had insufficient physical activity (59.7%).

Table 2 describes the correlation between variables by Spearman rank. Most correlations were not significant. Age and sleep had weak positive correlation (r=0.26, p=0.04). Physical activity had a moderate positive correlation with VO_{2max} (r=0.43, p<0.01). The correlation between sleep duration and VO_{2max} was not significant (r=0.23, p=0.07)

Table 2. The correlation by Spearman rank test

	Age	BMI	PA	Sleep	VO_{2max}
Age	1.000	-.161	.023	.260	.122
		.213	.882	.040*	.374
BMI	-	-	-.051	.173	.124
			.702	.191	.346
Physical activity	-	-	-	-.053	.433
				.715	<.011*
Sleep duration	-	-	-	-	.230
					.070

Note. * - indicates p is significant; italic number denotes p score; regular number denotes correlation coefficient (r). BMI - body mass index; PA - physical activity

The logistic regression of variables for 'good' VO_{2max} is presented in Table 3. The only physical activity was significant for VO_{2max}. Participants with 'sufficient' physical activity had a 14.5 times probability of having good VO_{2max} compared to 'insufficient' PA (95%CI 2.7-77.8, p=0.02)

Table 3. Logistic regression for VO_{2max}

Variables		Adjusted OR (95% CI)	p
Age	<20 years (reference)	0.27 (0.03-2.63)	0.26
	≥20 years		
BMI	Normo/underweight (reference)	1.90 (0.29-12.50)	0.51
	overweight/obesity		
Physical activity	Sufficient (reference)	14.5 (2.7-77.8)	0.02
	Insufficient		
Sleep duration	Normal (reference)	6E+008	0.99
	Insufficient		

Note. BMI - body mass index; OR - Odds ratio

Discussion

A study on the correlation between sleep duration and cardiorespiratory endurance test has not been much performed yet. This might be a part of a few studies on the association between sleep duration and cardiorespiratory endurance tests involving medical college students. Our findings indicated that sleep duration did not affect VO_{2max} in medical college students with a mean age of 19.5 years. Participants of this study were more overweight/obese with insufficient sleep duration and physical activity but having good cardiorespiratory endurance tests. Our finding demonstrated that only physical activity was related to VO_{2max}.

Our study observed no significant correlation between sleep duration and VO_{2max} results. Prior studies did not support this finding. A cohort study by Zou et al. investigated the association between insomnia and cardiorespiratory fitness (CRF) in middle-aged people. The results showed a modest association between insomnia and CRF (Zou et al., 2019). At the same time, another study by Countryman et al. observed that sleep quality was associated with CRF in adolescents (Countryman et al., 2013). We had no obvious explanation, but it might be related to age. Young people may have better cardiorespiratory function than middle-aged and adolescents leading to more stable function while facing stress tests.

A study that identifies factors associated with CRF has been performed. Kind et al. made a regression model to estimate VO-

$_{2max}$ in healthy adult workers (Kind et al., 2019). They observed gender, age, waist circumference, smoking habit, and resting heart rate were the most significant factors related to VO_{2max} while BMI did not (Kind et al., 2019). Magutah investigated CRF in college students in Kenya. They observed that year of study, age, weight, and respiratory rate were determinant factors for VO_{2max} results (Magutah, 2013). Aires et al. concluded that increased physical activity and reduced sedentary activities could achieve optimum CRF (Aires et al., 2011). Our findings demonstrated that only physical activity (PA) correlated with VO_{2max} but not with age, BMI, and sleep duration, even age and BMI of our study were relatively homogenous. We assumed that participants with better functional fitness might be more energetic and did not get tired easily, so they did not much sleep. Therefore, sleep duration had less impact on their performance during submaximal stress test (Kredlow, Capozzoli, Hearon, Calkins, & Otto, 2015).

The correlation between exercise and good sleep has been established. In adolescents, a study by Brand et al. reported that athletes had a night of better sleep and psychological functioning than controls (Brand et al., 2010). Banno et al. also stated in a systematic review that exercise could improve sleep quality (Banno et al., 2018). Also, Kline suggested that exercise and sleep had a bidirectional relationship (Kline, 2014). Our findings did not find any correlation between physical activity and sleep duration. This difference finding might be due to intensity of physical exercise. The previous study participants were athletes who trained with high exercise intensity than participants in our study.

Less sleep duration is common among medical students. Huen et al found that about 70% of medical students in Hong Kong reported sleep deprivation (Huen, Chan, Yu, & Wing, 2007), while our study demonstrated 82.3%. A study by Yadav et al. reported that low physical activity and CRF were found among medical students, especially in females (Yadav, Shete, Khan, 2015). Our findings showed that students had 'insufficient 'PA were slightly higher than those with 'sufficient' PA (59.7 vs 40.3%) but most students had a 'good' VO_{2max} (80.6%). These findings indicated that sleep was not an essential requirement for students with good VO_{2max} to achieve a better endurance test result.

We identified some limitations of the study. First, the sample size might be too small, which will significantly affect the statistical results. Second, we included sleep duration only rather than sleep quality. Long sleep duration does not mean good sleep quality. Third, a cross-sectional study less explains the causal-relationship effect. Fourth, the QCS test is a submaximal test that its ability to differentiate CRF between fit and less fit people is less accurate than a maximal test.

Conclusion

This study revealed that lower sleep duration in medical college students is common. However, inadequate sleep duration did not influence the results of the QCS test. Instead, the physical activity was a predictive factor for VO_{2max} from QCST, with OR was 14.5. We should interpret these results with caution due to some limitations. We recommend investigating with larger sample size and including sleep quality using a maximal test for CRF evaluation. The average night sleep duration of 6.2 hours may not affect the results of QCST in medical college students. The results could imply that a sleep duration of about 6 hours might be sufficient for young people to perform daily activities with sufficient quality.

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Conflict of Interest

The authors declare that there is no conflicts of interest.

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- 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@ucg.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

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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@ucg.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[1], Gytis Balilionis[1], Eric K. O'Neal[2]

[1]Elon University, Department of Exercise Science1, Elon, NC 27215
[2]University of North Alabama, Department of Health, Physical Education and Recreation, Florence, AL 35632

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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 Krustrup (2008) stated that
- ✓ Subséquent citation: Bangsbo et al. (2008) stated that

Works by six or more authors: cite only the name of the first author followed by et al. and the year

- ✓ Krustrup et al. (2003) studied
- ✓ In one study (Krustrup et al., 2003), soccer players

Two or more works in the same parenthetical citation: Citation of two or more works in the same parentheses should be listed in the order they appear in the reference list (i.e., alphabetically, then chronologically)

- ✓ Several studies (Bangsbo et al., 2008; Duffield & Marino, 2007; Reilly, 1997) suggest that

2.4.3. Examples for Reference list

Journal article (print):

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

Krustrup, P., Mohr, M., Amstrup, T., Rysgaard, T., Johansen, J., Steensberg, A., Bangsbo, J. (2003). The yo-yo intermittent recovery test: physiological response, reliability, and validity. *Medicine and Science in Sports and Exercise, 35*(4), 697-705. 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/newsevents/hydration

2.5. Tables

All tables should be included in the main manuscript file, each on a separate page right after the Reference section.

Tables should be presented as standard MS Word tables.

Number (Arabic) tables consecutively in the order of their first citation in the text.

Tables and table headings should be completely intelligible without reference to the text. Give each column a short or abbreviated heading. Authors should place explanatory matter in footnotes, not in the heading. All abbreviations appearing in a table and not considered standard must be explained in a footnote of that table. Avoid any shading or coloring in your tables and be sure that each table is cited in the text.

If you use data from another published or unpublished source, it is the authors' responsibility to obtain permission and acknowledge them fully.

2.5.1. Table heading

Table heading should be written above the table, in Title Case, and without a full stop at the end of the heading. Do not use suffix letters (e.g., Table 1a, 1b, 1c); instead, combine the related tables. *See* example:

- ✓ **Table 1.** Repeated Sprint Time Following Ingestion of Carbohydrate-Electrolyte Beverage

2.5.2. Table sub-heading

All text appearing in tables should be written beginning only with first letter of the first word in all capitals, i.e., all words for variable names, column headings etc. in tables should start with the first letter in all capitals. Avoid any formatting (e.g., bold, italic, underline) in tables.

2.5.3. Table footnotes

Table footnotes should be written below the table.

General notes explain, qualify or provide information about the table as a whole. Put explanations of abbreviations, symbols, etc. here. General notes are designated by the word *Note* (italicized) followed by a period.

- ✓ *Note.* CI: confidence interval; Con: control group; CE: carbohydrate-electrolyte group.

Specific notes explain, qualify or provide information about a particular column, row, or individual entry. To indicate specific notes, use superscript lowercase letters (e.g. $^{a, b, c}$), and order the superscripts from left to right, top to bottom. Each table's first footnote must be the superscript ^{a}.

- ✓ ^{a}One participant was diagnosed with heat illness and n = 19.^{b}n =20.

Probability notes provide the reader with the results of the texts for statistical significance. Probability notes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || etc.

- ✓ *P<0.05,†p<0.01.

2.5.4. Table citation

In the text, tables should be cited as full words. *See* example:

- ✓ Table 1 (first letter in all capitals and no full stop)
- ✓ ...as shown in Tables 1 and 3. (citing more tables at once)
- ✓ ...result has shown (Tables 1-3) that... (citing more tables at once)
- ✓ ....in our results (Tables 1, 2 and 5)... (citing more tables at once)

2.6. Figures

On the last separate page of the main manuscript file, authors should place the legends of all the figures submitted separately.

All graphic materials should be of sufficient quality for print with a minimum resolution of 600 dpi. 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 bellow the figure, in sentence case. *See* example:

- ✓ **Figure 1.** Changes in accuracy of instep football kick measured before and after fatigued. SR – resting state, SF – state of fatigue, *p>0.01, †p>0.05.

2.6.2. Figure citation

All graphic materials should be referred to as Figures in the text. Figures are cited in the text as full words. *See* example:

- ✓ Figure 1
  - × figure 1
  - × Figure 1.
  - ✓ ….exhibit greater variance than the year before (Figure 2). Therefore…
  - ✓ ….as shown in Figures 1 and 3. (citing more figures at once)
  - ✓ ….result has shown (Figures 1-3) that... (citing more figures at once)
  - ✓ ….in our results (Figures 1, 2 and 5)... (citing more figures at once)

2.6.3. Sub-figures

If there is a figure divided in several sub-figures, each sub-figure should be marked with a small letter, starting with a, b, c etc. The letter should be marked for each subfigure in a logical and consistent way. *See* example:

- ✓ Figure 1a
- ✓ …in Figures 1a and b we can…
- ✓ …data represent (Figures 1a-d)…

2.7. Scientific Terminology

All units of measures should conform to the International System of Units (SI).

Measurements of length, height, weight, and volume should be reported in metric units (meter, kilogram, or liter) or their decimal multiples.

Decimal places in English language are separated with a full stop and not with a comma. Thousands are separated with a comma.

Percentage	Degrees	All other units of measure	Ratios	Decimal numbers
✓ 10%	✓ 10º	✓ 10 kg	✓ 12:2	✓ 0.056
× 10 %	× 10 º	× 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*

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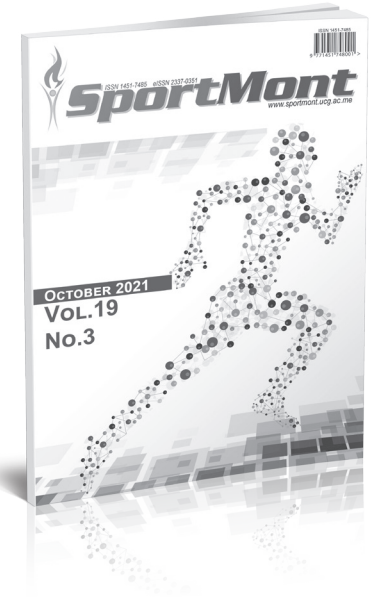

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- Post-publication tools to indicate quality and impact;
- Community-based dialogue on articles;
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SMJ is published three times a year, in February, June and October of each year. SMJ publishes original 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/?sekcija=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@ucg.ac.me or contact following Editors:

Publication date: Winter issue – February 2022
Summer issue – June 2022
Autumn issue – October 2022

EVROPSKA GRAĐANSKA PERSPEKTIVA

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EAPA-BCH

SCIENTIFIC PROJECT

Efekti autofagije i fizičke aktivnosti na tjelesnu kompoziciju, indeks tjelesne mase, stres, zdravstveno ponašanje, kognitivne sposobnosti i društvenu uključenost starijih osoba

(Projekat finansiran od strane Ministarstva nauke, direktorijata za mlade, a koji sprovodi Fakultet za sport i fizičko vaspitanje Univerziteta Crne Gore)

Glavni cilj projekta je da se primjenom naprednih praksi utvrde efekti autofagije i fizičke aktivnosti na tjelesnu kompoziciju, indeks tjelesne mase, trenutni nivo doživljaja stresa, zdravstveno ponašanje, kognitivne sposobnosti i nivo društvene uključenosti starijih osoba.

Projekat ima i svoj radni dio koji podrazumijeva organizovanje besplatnog vježbanja starijim osobama 3 puta nedeljno u trajanju od 6 mjeseci.

Učesnici mogu biti sve osobe iznad 50 godina a prijave se primaju na mail adresu fakultetzasportnk@ucg.ac.me i telefon fakulteta +38240235207. Svi su koji žele da uzmu aktivno učešće u ovom projektu koji njima može unaprijediti život, a naučnoj zajednici Crne Gore može donijeti značajna teorijska znanja koja će se u budućnosti koristiti u praktične svrhe su dobrodošli.

Svim učesnicim će na početku biti ponuđena najsavremenija dijagnostika, koja će im pružiti uvid u vlastito zdravstveno stanje, kako fizičko tako i kada su neki psihološki parametri u pitanju. Nakon toga će učesnici biti prema sopstvenim interesovanjima podijeljeni u grupe koje će raditi prema različitim programima.

1. Prva grupa će vježbati 3 puta nedeljno 6 mjeseci u prostorijama Fakulteta za sport i fizičko vaspitanje.

2. Druga će samo primjenjivati izmijenjeni način ishrane i voditi tačnu evidenciju o stepenu poštovanja zadataka koji im se postave. Ishrana će biti takva da se napravi pauza u unošenju hrane u trajanju 16 sati između poslednjeg dnevnog obroka i prvoga obroka u sledećem danu, a sve u cilju pokretanja procesa Autofagije koji ima blagotvorno dejstvo na organiza.

3. Treća grupa će kombinovati vježbanje i izmijenjenu ishranu, tj. biće kombinacija prethodno pomenutih zadataka.

4. Četvrta grupa će biti kontrolna. Njeni članovi će proći dijagnostiku i pomoći da se utvrdi kakve su prirodne promjene u organizmu za pomenuti šestomjesečni period, odnosno da li ih ima.

Svim prijavljenim osobama, koje imaju interesovanje za to, će prije poćetka rada biti održana dva predavanja o pomenutom izmijenjenom načinu ishrane koji danas postaje sve popularniji u svijetu pa ga primjenjuju i vrhunski sportisti poput Novaka Đokovića.

Još jednom treba napomenuti da će svaka od 4 grupe na poklon dobiti najsavremeniju dijagnostiku kompletnog psihofizičkog stanja koja je inače i nedostupna i skupa.

Prijavljivanje može da počne odmah, broj učesnika za grupe koje bi vježbale u prostorijama fakulteta je ograničen.

VLADA CRNE GORE
MINISTARSTVO NAUKE

Fakultet za sport i fizičko vaspitanje • Univerzitet Crne Gore •

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Montenegrin Journal of Sports Science and Medicine

MONTENEGRIN JOURNAL OF SPORTS SCIENCE AND MEDICINE

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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;
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- Worldwide media coverage.

MJSSM is published biannually, in September and March of each year. MJSSM publishes original scientific papers, review papers, editorials, short reports, peer review - fair review, as well as invited papers and award papers in the fields of Sports Science and Medicine, as well as it can function as an open discussion forum on significant issues of current interest.

MJSSM covers all aspects of sports science and medicine; all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side.

Prospective authors should submit manuscripts for consideration in Microsoft Word-compatible format. For more complete descriptions and submission instructions, please access the Guidelines for Authors pages at the MJSSM website: http://www.mjssm.me/?sekcija=page&p=51. Contributors are urged to read MJSSM's guidelines for the authors carefully before submitting manuscripts. Manuscripts submissions should be sent in electronic format to office@mjssm.me or contact following Editors:

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MONTENEGRIN SPORTS ACADEMY

Founded in 2003 in Podgorica (Montenegro), the Montenegrin Sports Academy (MSA) is a sports scientific society dedicated to the collection, generation and dissemination of scientific knowledge at the Montenegrin level and beyond.

The Montenegrin Sports Academy (MSA) is the leading association of sports scientists at the Montenegrin level, which maintains extensive co-operation with the corresponding associations from abroad. The purpose of the MSA is the promotion of science and research, with special attention to sports science across Montenegro and beyond. Its topics include motivation, attitudes, values and responses, adaptation, performance and health aspects of people engaged in physical activity and the relation of physical activity and lifestyle to health, prevention and aging. These topics are investigated on an interdisciplinary basis and they bring together scientists from all areas of sports science, such as adapted physical activity, biochemistry, biomechanics, chronic disease and exercise, coaching and performance, doping, education, engineering and technology, environmental physiology, ethics, exercise and health, exercise, lifestyle and fitness, gender in sports, growth and development, human performance and aging, management and sports law, molecular biology and genetics, motor control and learning, muscle mechanics and neuromuscular control, muscle metabolism and hemodynamics, nutrition and exercise, overtraining, physiology, physiotherapy, rehabilitation, sports history, sports medicine, sports pedagogy, sports philosophy, sports psychology, sports sociology, training and testing.

The MSA is a non-profit organization. It supports Montenegrin institutions, such as the Ministry of Education and Sports, the Ministry of Science and the Montenegrin Olympic Committee, by offering scientific advice and assistance for carrying out coordinated national and European research projects defined by these bodies. In addition, the MSA serves as the most important Montenegrin and regional network of sports scientists from all relevant subdisciplines.

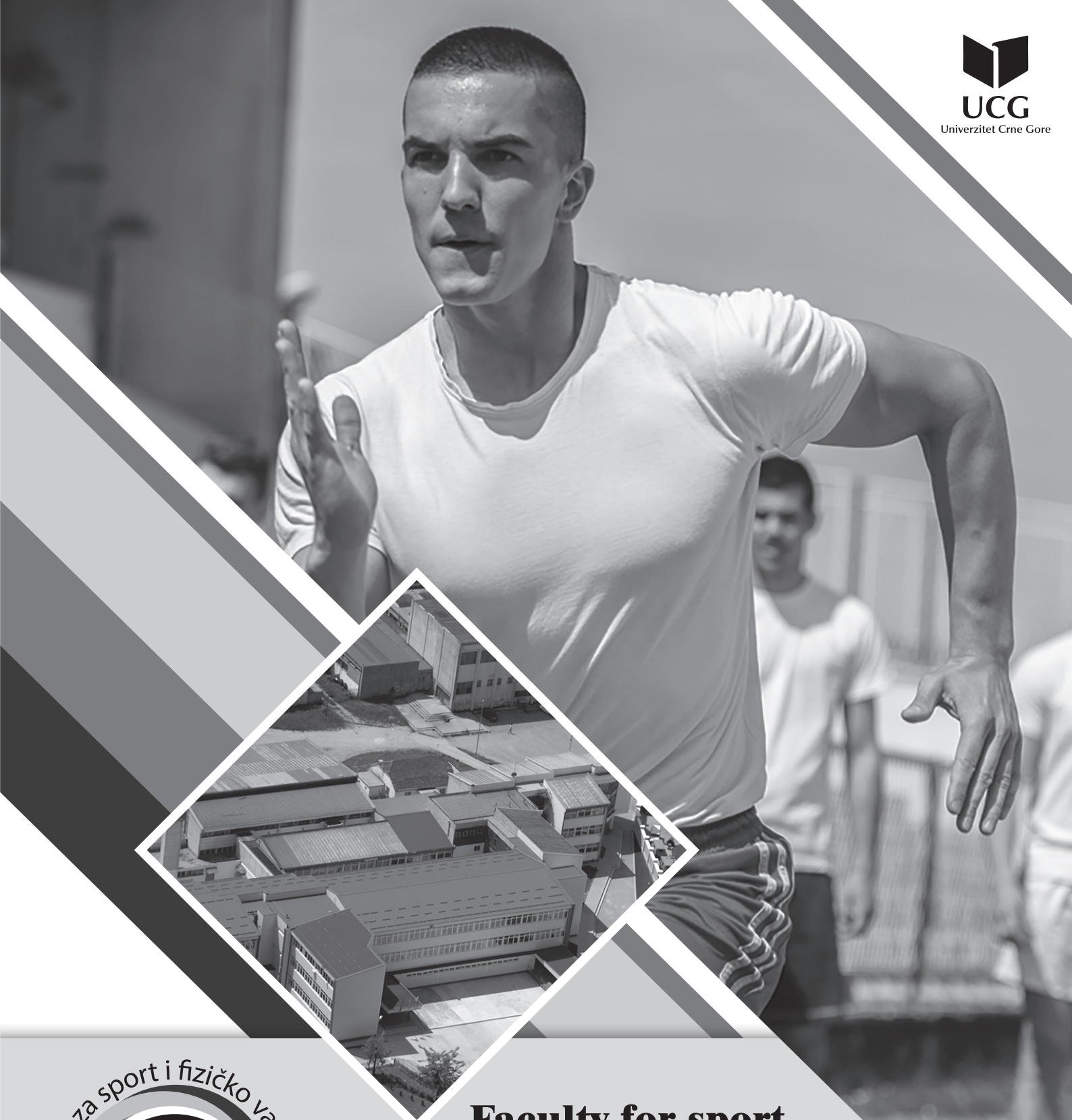
The main scientific event organized by the Montenegrin Sports Academy (MSA) is the annual conference held in the first week of April.

Annual conferences have been organized since the inauguration of the MSA in 2003. Today the MSA conference ranks among the leading sports scientific congresses in the Western Balkans. The conference comprises a range of invited lecturers, oral and poster presentations from multi- and mono-disciplinary areas, as well as various types of workshops. The MSA conference is attended by national, regional and international sports scientists with academic careers. The MSA conference now welcomes up to 200 participants from all over the world.

It is our great pleasure to announce the upcoming 19th Annual Scientific Conference of Montenegrin Sports Academy "Sport, Physical Activity and Health: Contemporary Perspectives" to be held in Dubrovnik, Croatia, from 7 to 10 April, 2022. It is planned to be once again organized by the Montenegrin Sports Academy, in cooperation with the Faculty of Sport and Physical Education, University of Montenegro and other international partner institutions (specified in the partner section).

The conference is focused on very current topics from all areas of sports science and sports medicine including physiology and sports medicine, social sciences and humanities, biomechanics and neuromuscular (see Abstract Submission page for more information).

We do believe that the topics offered to our conference participants will serve as a useful forum for the presentation of the latest research, as well as both for the theoretical and applied insight into the field of sports science and sports medicine disciplines.



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"Sport, Physical Activity and Health: Contemporary perspectives"

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