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ORIGINAL SCIENTIFIC PAPER

Effects of Cryokinetics on Hand Function of Patients with Spinal Cord Injury

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Abstract

This study investigated the effects of cryokinetics on hand function of subjects with spinal cord injury. The present study has an experimental design. Thirty-nine subjects with upper spinal cord injury were included. Handgrip and pinch strength were measured using electronic hand dynamometer (in kg) and mechanical pinch gauge (in kg) respectively prior to and following an 8-week cryokinetics. The amount of handgrip and pinch strength of both hands generated by each participant was used as a quantitative measurement of the development of hand function. Inferential statistics of multiple analysis of variance was used to analyze the data. Statistical significance was retained for p value <0.05. The results of this study revealed that the strength training and the cryotherapy programmes separately had insignificant ($p>0.05$) effects on the hand function of the subjects. However, cryokinetics had significant ($p<0.05$) effects on the hand function of subjects with upper spinal cord injury. It was therefore concluded that the strength training programmes and cryotherapy individually cannot substantially influence hand function of subjects with upper spinal cord injury whereas, cryokinetics can substantially enhance hand function of the participants. Thus, cryokinetics is an excellent intervention protocol for optimizing hand function of subjects with upper spinal cord injury. It was therefore recommended that cryokinetics should be regarded as keystone in the management of subjects with upper spinal cord injury.

Keywords: *Cryokinetics, Hand function, Spinal cord injury*

Introduction

Spinal cord injury (SCI) could cause alterations in the structure and functions of spinal cord that might result to motor dysfunctions such as difficulty in walking and the use of hands, thereby, leading to restriction in daily activities (Draulans, Kiekens, Roels, & Peers, 2011). Rehabilitation medicine emphasizes strengthening exercises and functional training for self-adequacy and mobility. This practice may have overlooked some other physical rehabilitation protocols such as cryotherapy, which might have some health benefits. Thus far, evaluation of hand function following cryotherapy is hardly ever evident in the rehabilitation programme, while assessment of grip strength and hand function after strength training (ST) is carefully documented (Hammed, Agbonlahor, Ogbouma, Arainru, Adodo, & Ogbeivor, 2022). Individuals with paralysis of upper and lower extremities (tetraplegia) recognize restoration of hand and arm function as indispensable for functional recovery; whereas individuals with paralysis of the lower extremities (paraplegia) mention walking as their prime concern (French, Anderson-Erisman & Sutter, 2010). Thus, the functions of the upper extremity are mostly affiliated with the performance of daily activities and gregarious participation. The upper extremities allow for complex task accomplishment in exploration, prehension, precision, reaching, adaptation, perception as well as manipulation.

The hand is the main effector of the upper extremity whereas the wrist, elbow, and shoulder joints function to position the hand in space (Harris & Eng, 2007). For optimum productivity, ample muscle power is required while decline in muscle strength is a prognosticator of physical limitations (Hammed & Adodo, 2017). The functions of the upper extremity can also be determined by the joint movement, stability, and strength. Furthermore, joint flexibility is very crucial to general wellbeing and functionality

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(Ribeiro, Campos-Filho, Avelar, dos-Santos, Júnior, Aguiara, … & Cyrino, 2017). The shortness and tightness of muscles as a result of disuse could cause an increase in injury and strains as well as reduction in joint flexibility. Grip and pinch strengths have been shown to have significant influence on the function of the upper extremity (Kim, 2016).

Cryokinetics is a technique in which cold is applied for few minutes, and then followed by strength exercise (Knight & Draper, 2013). It remains untold, how frequent, or to what extent, ST and cryotherapy are capable of enhancing the hand function of individuals after SCI. The effects of ST on hand function after SCI have been controversial in previous evidence, while the effects of cryotherapy are poorly documented. Therefore, this study was designed to investigate the use of cryokinetics to challenge hand dysfunctions associated with SCI. The objective is to assess if there are differences in the hand function of subjects with SCI exposed and not exposed to cryokinetics.

Methods

The pretest-posttest control group experimental design was adopted in this study. The study population included 60 participants with upper SCI that were admitted at the Division of Neurosurgery, Department of Surgery, University of Benin Teaching Hospital (UBTH), Benin-City (UBTH Medical Record, 2021). Thirty-nine participants with upper incomplete SCI participated in this study. The judgmental sampling technique was employed to recruit the participants. A simple random sampling technique of balloting with replacement was then used to assign the participants into four different groups. The 1st group was recognized as the control group while the 2nd, 3rd and 4th groups were experimental groups. Ten participants were assigned to each of the experimental groups and nine participants were assigned to the control group. Two attritions were recorded and a total number of thirty-seven participants completed the study. Ethical approval was sought and obtained from the Ethics and Research Committee of the University of Benin Teaching Hospital, Edo State, Nigeria (ADM/E 22/A/VOL.VII/148273).

The subjects in the control group received conventional daily treatment protocols (usual treatment protocols), the subjects in the experimental group 1 received usual treatment protocols plus ST programmes, the subjects in the experimental group 2 received usual treatment protocols plus cryotherapy while the subjects in the experimental group 3 received usual treatment protocols plus cryokinetics. The conventional daily treatment protocols were administered on Mondays, Tuesdays, Wednesdays, Thursdays and Fridays between 9am to 12pm. The intervention protocols were administered on Mondays, Wednesdays and Fridays between 2pm to 4pm. All the intervention protocols were administered for 8-weeks. The ST programme protocol was adapted from Kwak, Kim and Lee (2016). Handgrip and pinch strength were measured using electronic hand dynamometer (in kg) and mechanical pinch gauge (MPG) (in kg) respectively, prior to, and following an 8-week intervention.

Handgrip Strength Measurement

The American Society of Hand Therapists guidelines (Schreuders, Roebroeck, Goumans, Van-Nieuwenhuijzen, Stijnen & Stam, 2003; Fess, 1992) was followed in the measurement of hand grip strength. The subject lies supine comfortably in postural reduction, with 90° of elbow flexion and the forearm and wrist in a neutral position. The researcher demonstrates to each participant on how to use the device to familiarize the participant with the use of the apparatus and to remove the element of fear. Three maximum power gripping trials were made by each hand of the participant, with three-second contractions and ten-second rest periods between the attempts, and only the best of the three attempts was recorded. No assistance of the hand under test was allowed. The device was adjusted for variant hand sizes and preferences by adjusting the center knob. All readings were recorded in kilograms in the present study.

Pinch Strength Measurement

The guidelines of Schreuders et al. (2003) was followed in the measurements of pinch strength. The MPG was zeroed prior to testing of each pinch with the rotation of the small curled knob on top of the dial indicator in an anticlockwise direction until it rests against the black pointer at the zero marking. A single maximum effort was recorded for key pinch, palmer pinch and tip pinch because muscle fatigue begins with the first concentrated effort. The following test instructions were provided: "you must squeeze the handle as hard as possible keeping both your body and arm in position". All readings were recorded in kilograms in the present study.

Key pinch (lateral pinch)

The subject comfortably lies supine in postural reduction, with the test arm at the side and elbow flexed 90°, palm facing inward, while the MPG gauge is placed between the flexed proximal interphalangeal joint of index finger and thumb. The researcher stood in front of the subject to the side holding the MPG and the subject was asked to hold, squeeze and, release the gauge. That is, subject applied pinch force at the pinch groove while holding the pinch gauge between his/her thumb and index fingers.

Palmer pinch (chuck pinch)

The subject suitably lies supine with the test arm at the side and elbow flexed 90°, palm facing downward. The subject held pinch gauge between thumb and the index and middle fingers. The researcher stood in front of the subject to the side holding the gauge and the subject was asked to hold, squeeze and, release the gauge.

Tip pinch (thumb-index pulp pinch)

The subject suitably lies supine with the test arm at the side and elbow flexed 90°, palm facing downward. The pinch gauge was between thumb and test finger in the absence of interpose of other fingers. The researcher stood in front of the subject to the side holding the MPG and the subject was asked to hold, squeeze and, release the gauge.

Hand Function

This study made use of handgrip strength and pinch strength as an overall quantitative assessment of hand function, extrapolating the works of Weiss and Flatt (1971) and Dickson and Calnan (1972). The magnitude of the handgrip strength and pinch strength (key pinch, palmer pinch and tip pinch) measured in kilograms produced by each participant was summed up and recorded as hand function for each subject as previously done by Schreuders et al. (2003). Higher handgrip and pinch strengths indicate better hand function. The right and left hand function for each subject were recorded and analyzed separately. The best of the three attempts was recorded for the grip strength but a single maximum effort was recorded for pinch strength because muscle fatigue begins with the first concentrated effort.

The ST is an exercise training program in which the subjects were exposed to repeated period of work, interspersed with rest periods. ST program (Tables1) was consisted of exercises to strengthen the key muscles of the upper limbs of the subjects at a frequency of 3 times a week (Monday, Wednesday and Friday). Each day's workout commenced with stretching and range of motion (ROM) exercise to warm up the joints and prepare the body

for the resistance training. This procedure minimized the risk of body discomfort or damage and, enhanced the benefit of the training. The resistance training was carried out for 15 minutes per session for each of the upper extremity. Each session comprised of one set of 5 repetitions for each upper limbs' joints. Each of these movements was performed against the elastic theraband for 1.5 minutes with 1-minute rest between the joints. The theraband with lower resistance was used in the first 4 weeks of the training. The training was progressed with the use of theraband with higher resistance for the last four weeks.

Table 1: Elastic-Band Resistance Exercise Programmes for Upper Extremities

Warm-up exercise	Stretching	3 minutes
	ROM Exercise	
Resistance exercise	Wrist flexion ($5^a \times 1.5^b$)	15 minutes, 3 times/week (8 weeks)
	Wrist extension ($5^a \times 1.5^b$) + resting time (1^b)	
	Elbow flexion ($5^a \times 1.5^b$)	
	Elbow extension ($5^a \times 1.5^b$) + resting time (1^b)	
	Shoulder flexion ($5^a \times 1.5^b$)	
	Shoulder adduction ($5^a \times 1.5^b$) + resting time (1^b)	
	Shoulder abduction ($5^a \times 1.5^b$)	
Warm-down exercise	Soft tissue mobilization	2 minutes
	Deep breathing exercise	

[a]times, [b]minutes

The cryotherapy was targeted to enhance hand function and joints flexibility of upper extremities. After the researcher's hands were washed, an ice bag (20.3×40.6 cm) filled-up with 1.5 liter of flaked ice was applied with an elastic bandage each at the wrist, elbow, and shoulder joints of upper limbs. Waterproof material was kept under each joint (area) and the area was checked after ice application for frostbite. The flaked ice was applied on each joints of upper limbs for 2.5 minutes. In general, the ice bag was applied for 15 minutes and the area was cleaned with a dry towel. This procedure was carried out 3 times a week (Monday, Wednesday and Friday).

The cryokinetics is the combination of the cryotherapy and the ST program. Here, the subjects underwent the same procedure for cryotherapy as explained previously, and then was followed by the ST program.

Furthermore, the daily treatment for all experimental groups comprised of manual therapy of cardiopulmonary, passive joints and soft tissue mobilization protocols and pain management procedures. These interventions were carried out for a maximum of 30 minutes.

Statistical analysis

An inferential statistic of one-way MANOVA was adopted to analyze the difference in the hand function of subjects with SCI exposed and not exposed to cryokinetics. The Holm's Sequential Bonferroni Correction post hoc test was used in the case of significant main or interaction effects of the test variable. Statistical significance was accepted for p-value <0.05.

Results

Table 2 shows the results of multivariate test. A statistically significant ($p<0.05$) difference was found in the hand function of the subjects exposed and not exposed to cryokinetics. This however, necessitated probing into the post-hoc test to investigate the interaction effects of the independent intervention groups on hand function of the subjects. The results of these interactions are presented in Table 3.

Table 2: One-Way MANOVA Showing the Main and Interaction Effects of Cryokinetics on Hand Function of the Subjects

Dependent Variable	F	P value
RHF	5.317	<0.001
LHF	5.634	<0.001
RHF	228.644	<0.001
LHF	238.632	<0.001
RHF	5.317	<0.001
LHF	5.634	<0.001

RHF-right hand function, LHF-left hand function

Table 3 shows the post-hoc test results of the mean differences in hand function of the subjects. For the right hand function, all the pair wise of mean difference were found to be statistically insignificant ($p>0.05$, data not shown) except pre ST versus post CK (-7.270*), pre CT versus post CK (-6.410*), pre CK versus post CK (-8.210*), pre Control versus post CK (-5.282*), post CT versus post CK (-5.410*), post CK versus pre ST (7.270*), post CK versus pre CT (6.410*), post CK versus pre CK (8.210*), post CK versus pre Control (5.282*) and post CK versus post CT (5.410*). Likewise, for the left hand function, pre ST versus post CK (-7.386*), pre CT versus post CK (-6.600*), pre CK versus post CK (-7.770*), pre Control versus post CK (-5.205*), post CT versus post CK (-5.600*), post CK versus pre ST (7.386*), post CK versus pre CT (6.600*), post CK versus pre CK (7.770*), post CK versus pre Control (5.205*) and post CK versus post CT (5.600*) as reflected in Table 3. This implies that the entire pair wise mean had variation. Therefore, the ST and CT separately had no substantial influence on the hand function of the subjects. However, cryokinetics (CK) had substantial influence on the hand function of the subjects.

Table 3: Holm's Sequential Bonferroni Correction Post-Hoc Comparisons of Mean Difference for the Hand Function of the Subjects

Dependent Variable	(I) MANOVA	(J) MANOVA	Mean Difference (I-J)	P value
RHF	Pre ST	Post CK	-7.270*	<0.001
	Pre CT	Post CK	-6.410*	0.002
	Pre CK	Post CK	-8.210*	<0.001
	Pre control	Post CK	-5.282*	0.042
	Post CT	Post CK	-5.410*	0.017
	Post CK	Pre ST	7.270*	<0.001
	Post CK	Pre CT	6.410*	0.002
	Post CK	Pre CK	8.210*	<0.001
	Post CK	Pre control	5.282*	0.042
	Post CK	Post CT	5.410*	0.017
LHF	Pre ST	Post CK	-7.386*	<0.001
	Pre CT	Post CK	-6.600*	0.001
	Pre CK	Post CK	-7.770*	<0.001
	Pre control	Post CK	-5.205*	0.029
	Post CT	Post CK	-5.600*	0.006
	Post CK	Pre ST	7.386*	0.000
	Post CK	Pre CT	6.600*	0.001
	Post CK	Pre CK	7.770*	0.000
	Post CK	Pre control	5.205*	0.029
	Post CK	Post CT	5.600*	0.006

RHF-right hand function, LHF-left hand function, ST-strength training, CT-cryotherapy, CK-cryokinetics
*Only statistically significant results are presented (P<0.05)

Discussion

The result of the MANOVA on the effect of ST on hand function of the subjects indicated that the ST administered had no considerable effect on the subjects' hand function. This finding is in disagreement with Hammed, Adodo and Agwubike (2018); Agbonlahor and Hammed (2017); Agbonlahor and Hammed (2016); Bacchi, Negri, Targher, Faccioli and Lanza (2013) who found a significant effect of ST on grip strength and hand function in subjects with SCI. This might be due to differences in the methodological design because previous authors did not test for pinch strength in their study. Our results are also opposing the reults of Lisa, Sarah, Leonid, Ya-Seng and Mary (2011) who reported that an 8-week programme of intensive unilateral hand training including ST improves hand function of subjects with SCI. This might be again related to differences in the study methods such as intervention protocols, subject characteristics or variations in measuring instruments, variations in the degree or clinical features of SCI levels and so on. Moreover, the insignificant improvement in hand function found in the present study following ST can be adjudged in two different standpoints. Firstly, poor grip strength as the origin of first episode of poorer hand function. This is because the grip strength shows the strength generated by the contraction of the many arm and hand muscles required in the proper functioning of the hand. Likewise, there is a consensus that grip strength is a predictor of hand function and is mostly employed to determine functional limitation of the hand (Ruprai, Tajpuriya, & Mishra, 2015). Secondly, the insignificant effect of ST programme on the intrinsic and extrinsic muscles of the hand and forearm which enable the hand to function properly might also explain why there was no significant improvement of the hand function in the present study following ST program

Moreover, the results of the MANOVA on the efficacy of CT on hand function of the subjects indicated that the CT administered had no substantial effect on the subjects' hand function. This finding is in line with the study of Bhandari and Parmar (2014). In contrast, the result of the present study disagrees with the studies of Abd El-Maksoud, Sharaf and Rezk-Allah (2011) and Ariela, Priscila, Alderico, Fernanda and Mario (2019) who reported that CT was effective in increasing the patients' palmar grip strength and hand function. However, discrepancies which exist in the present and previous studies include different population, variation in the number of subjects, different intervention protocols and nuances in measuring instruments. Cryokinetics was observed to have significant influence on hand function in this study. The post hoc analysis equally shows that cryokinetics can significantly optimize hand function of subjects with upper SCI as compared with ST and CT separately. Cryokinetics is a technique that combines application of cold pack directly on the joints followed by a strength exercise (Knight & Draper, 2013). ST can cause structural and functional alteration in the cerebral cortex, spinal cord, and skeletal muscles, thereby optimizing neural and muscular function after SCI (Ehrhardt & Morgan, 2005). Furthermore, ST seems to enhance nerve regeneration with functional recovery, to cause corticospinal pathway connectivity, to ensure the functional status of spinal cord neurons, to activate skeletal muscle satellite cells, and to enhance muscle fiber regeneration (Li, Ding, Y.H., Rafols, Lai, McAllister & Ding, 2005). Several studies have reported significant effects of ST on muscle function (Flavia, Katia, Ana, Kesley, Isis, Humberto, Jose, & Maria, 2018; Serra-Ano, Pellicer, Xavier, Jose, Pascual, & Gonalez, 2012; Bye, Harvey, & Gandevia, 2017). Moreover, nerve excitation and contraction of skeletal muscles can be elicited by application of ice directly on the joints, that is, joint cryotherapy (Pietrosimone & Ingersoll, 2009). Thus, the results in our study may be a reflection

of the benefit of combined intervention protocols (ST and CT) to bring about better muscle function.

Conclusion

It can be concluded from this study that ST and CT separately cannot influence hand function of subjects with upper SCI. However, cryokinetics (combination of ST and CT) can substantially influence hand function of subjects with upper SCI. The study therefore revealed that cryokinetics is a good training modality for improving hand function of subjects with upper SCI.

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Contributors

AIH conceived the study. OSK, AO, DA and EO provided additional important intellectual and substantial scientific input to all drafts of the study. AIH is guarantor for the study.

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Competing interests

The authors have declared that no competing interests exist.

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ORIGINAL SCIENTIFIC PAPER

Exercise-Based Injury Prevention in Amateur Soccer: A Survey of Current Practices of 52 Algerian Teams

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Abstract

This study aims to investigate the injury prevention exercises used by Algerian amateur soccer teams. The present study collected data from some Algerian amateur soccer teams (From the second to the seventh division), during the season 2021–2022 (n = 52). A four-section online survey was responded. Only 12% of the teams use FIFA 11+. They often use activation and coordination exercises (72.4%), dynamic stretching (69.8%), and agility exercises (68.6%), but they sometimes use sprint and high-speed running (52.4%), concentric (53%), isometric (59%), vertical plyometric (59.4%), horizontal plyometric (56.2%), core exercises (63.2%), static stretching (63.8%), multi-joint exercises (63.2%), single leg strength and stability (61%), and they rarely use eccentric exercises (50.2%). Most coaches reported that they use these exercises during preparation and competition phases and they use them with all players. The investigation provided insight into the current use of injury prevention exercises by Algerian amateur teams, highlighting that several clubs used them, although there are differences between them in the extent of use. Moreover, this study provides information that may be useful for improving injury prevention strategies for amateur soccer teams.

Keywords: *non-contact injuries, injury prevention, preventive exercises, amateur soccer, teams' practices, Algerian coaches*

Introduction

Soccer is the most popular sport in the world with about 270 million participants (FIFA, 2007), and it is a high intensity contact sport that require a high physical level for match play, and this makes it the focus of many researchers in the sports field to achieve two main goals: improving performance and preventing injuries.

Injuries are part of soccer, and they occur frequently during games and training (López-Valenciano et al., 2019). However, many studies have shown that the incidence of injuries is higher in matches than in training (López-Valenciano et al., 2019; Ekstrand et al., 2009; Pfirmann et al., 2016). On the contrary, a Dutch study has shown that more injuries in amateur soccer occur during training (Van Beijsterveldt et al., 2015). These injuries also vary, including contact and non-contact injuries (Gizaa, and Michelib, 2005). Perhaps the most prominent existing efforts are focused on the prevention of non-contact injuries, including muscles, joint and ligament injuries (Lemes et al., 2021).

There are many ways to prevent non-contact injuries, and maybe the most effective is the reliance on certain physical ex-

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ercises (Chatterjee et al., 2015; McCall et al., 2020). In recent studies, it has been reported that sprint exercises are an effective limit for preventing injuries, especially in the hamstring muscle (Freeman et al. 2018; Mendiguchia et al., 2020; Prince et al., 2020). Goode et al. (2015) also have shown through a systematic review that eccentric training like Nordic exercise is effective in reducing hamstring injury.

There are also some programs aimed to improve neuromuscular control and reducing the risk of injury, which often contain strength, core, proprioception, plyometric and agility exercises under the name of neuromuscular training (Emery et al., 2015). These programs are often carried out in the form of warm-ups. FIFA 11+ (Bizzini et al., 2011), Harmoknee (Kiani et al., 2010), Sprortsmetrics injury prevention program (Noyes, & westin, 2012), and the Prevent Injury and Enhance Performance program (PEP) (Gilchrist et al., 2008), are examples to those programs.

Stretching exercise are also considered among the exercises used to prevent injuries (Thacker et al., 2004). Several studies have demonstrated its significant role in injury prevention and this is related to both types, static (Amako et al., 2003) and dynamic stretching (Costa et al., 2014).

The use of previous exercises varies from one team to another and from one level to another. Meurer et al. (2017) found that all Brazilian professional clubs used strength and functional training, core, balance/proprioception and eccentric exercises in their injury prevention program, while 88% of the clubs used FIFA 11+ program. McCall et al. (2014) found from a study on 44 teams from various premier leagues, that the preventing exercises used by these clubs were eccentric exercise, balance/proprioception, hamstring eccentric, core stability, Nordic hamstring and gluteus activation.

Injury prevention exercises are some of the most efficient tools for every coach or strength and conditioning coach when they want to protect their players from upcoming injuries. The purpose of this research is to describe the injury prevention exercises used by Algerian amateur soccer coaches.

Materials and methods

Participants

52 teams active in various Algerian amateur divisions (from the second to the seventh division) participated in this study for the 2021/2022 season. The survey was answered by the head coach or the strength and conditioning coach, if available in the team. The study was carried out following the Helsinki Declaration. The coaches have been informed of the aims of the study, their rights have been preserved, and they have participated voluntarily, and given the possibility to withdraw at any time.

Study design

In this study, a survey was relied on as a means of data collection to know the use of injury prevention exercises by Algerian amateur soccer teams. It consisted of a set of questions using check-boxes, multiple choice, free-text responses, and Likert scale. The validity of the survey and the clarity of its questions were confirmed by testing it on 4 amateur teams, and they were not included in the study.

The survey was built by looking at some previously published surveys (Meurer et al., 2017; McCall et al., 2020). And it was available online in arabic (https://forms.gle/rHhQtz9dXtKL9THa6) from September 19, 2021 to March 12, 2022.

Data collection method

The survey was divided into four sections. The first section included information about the team and the exercises they use in preventing injuries. The second section included questions about the use of injury prevention exercises, and the answer was yes or no. The third section consisted of questions to gather more accurate information about the extent to which these exercises are applied by answering: never, rarely, sometimes, often, and always. This is followed by the fourth section, which contained some additional questions about the use of these exercises (availability of equipment, its source, the phase of the season in which it is applied, the target players, and where they are implemented).

Statistical analysis

Data were analyzed using descriptive statistics. Mean ($\bar{x}$), standard deviation (SD), and percentages (n, %) were used according to the type of question, and Likert quintuple scale was used to answer the questions regarding the extent to which injury prevention exercises were applied as previously explained.

Results

52 Algerian teams from 25 states who are active in amateur leagues participated in the survey. Most of them are active in the honor division (sixth division) (30.8%), followed by the second division teams (17.3%), the third division teams (15.4%) and the pre-honorary division (seventh division). As for the first regional division teams (4th division), 11.5% of the total teams that answered the survey participated, as well as the second regional division teams (fifth division) participated with 9.6% (Table 1).

Table 1. Level of league worked in by coaches who responded

Second division	Third division	Regional 1	Regional 2	Honor	Pre-honor
9	8	6	5	16	8

These teams train from 3 to 6 sessions per week (4.19 ± 0.76 sessions), while only 37 teams use injury prevention exercises (71.15%), 12 of them use FIFA 11+ (32.43%), and they use injury prevention exercises as shown in Table 2.

Table 2. Injury prevention exercises used by Algerian amateur soccer teams

	Do you use this injury prevention exercises			
	Yes		No	
Exersises	N	%	N	%
Sprinting and high-speed running	21	56.75	16	43.25
Eccentric	24	64.86	13	35.14
Concentric	27	72.97	10	27.03
Isometric	29	78.37	8	21.63

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Table 2. Injury prevention exercises used by Algerian amateur soccer teams

	Do you use this injury prevention exercises			
	Yes		No	
Exersises	N	%	N	%
Vertical plyometric	23	62.16	14	37.84
Horizontal plyometric	22	59.45	15	40.55
Core exercises	35	94.59	2	5.41
Static stretching	28	75.67	9	24.33
Dynamic stretching	30	81.08	7	18.92
Activation and coordination	33	89.18	4	10.82
Resisted sprints	11	29.72	26	70.28
Multi-joint exercises	32	86.48	5	13.52
Single leg strength and stability	36	97.29	1	2.71
Agility	34	91.89	3	8.11

Twenty-three out of 40 coaches answered that they do not have enough equipment used in injury prevention exercises (57.5%) and 17 answered that they do have the required equipment (42.5%). Additionally, 77.5% of them rely on videos as a source for these exercises, 62.5% on websites, 57.5% on books, and 50% on researches and articles.

Most coaches answered that they focus on injury prevention exercises in both the pre-season and in-season phases (67.5%), and 27.5% of them reported that they focus on these exercises during the pre-season only, and 5% in-season phase only.

90% of the coaches answered that they apply these exercises to all players, while 10% answered that they only use them for players at risk of injury. Regarding the place of its application, most coaches apply it in both the stadium and in the gym (65%), while 32.5% apply it in the stadium only and 2.5% in the gym only.

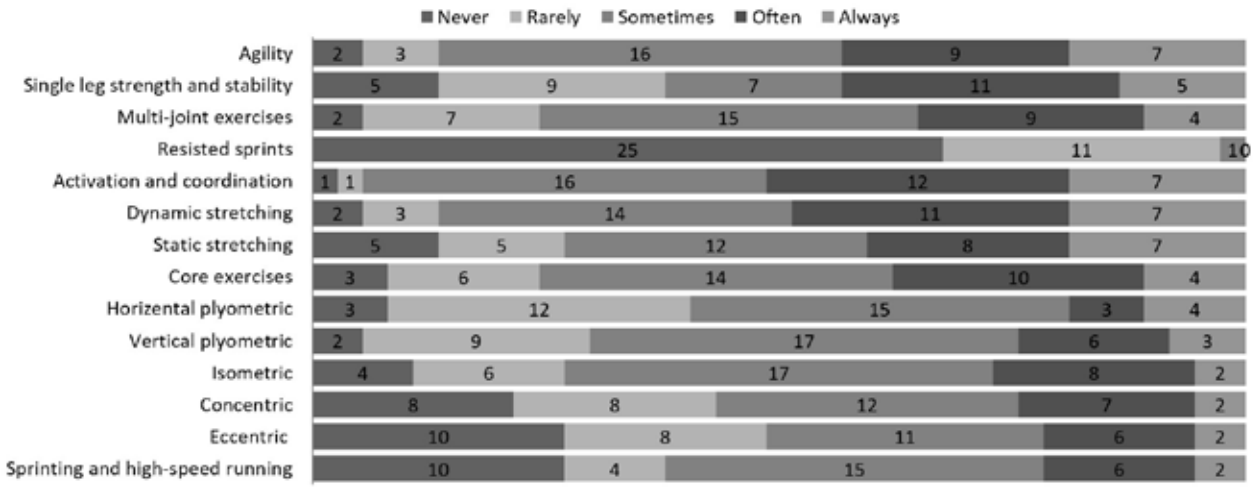

FIGURE 1. The extent to which Algerian amateur soccer teams used injury prevention exercises

Discussion

Concerning the FIFA 11+ warm-up program, it is considered among the training programs to help reduce the risk of injury by about 30% (Sadigursky et al., 2017) or 41% (Owoeyeet al., 2014). The results of the current study differed from the study of Meurer et al. (2017), which found that 88% of professional Brazilian teams use FIFA 11+.

Main findings of this study indicate that coaches often use activation and coordination exercises (72.4%), dynamic stretching (69.8%), and agility exercises (68.6%) as injury prevention exercise (Figure 1). These exercises are usually used in the warm-up, and they are effective in preventing injury, enhancing neuromuscular control (Emery et al., 2015), and improving joint functionality (Zech et al., 2009).

The exercises that they sometimes use are sprint and high-speed running (52.4%), concentric (53%), isometric (59%), vertical plyometric (59.4%), horizontal plyometric (56.2%), core exercises (63.2%), static stretching (63.8%), multi-joint exercises (63.2%), single leg strength and stability (61%), McCall et al. (2020) found out that these exercises are effective to prevent injuries, with balance/proprioception and core stability exercises being the most effective exercises for injury prevention that were used by professional teams (McCall et al., 2014). On the contrary, according to Mendiguchia et al., (2020) the most effective exercises for injury prevention are sprint and high speed running.

Coaches rarely use eccentric exercises (50.2%). However, McCall et al. (2014) shown that teams make a great use of eccentric exercises, especially the Nordic exercise. In addition, Small et al. (2009) found that the use of eccentric exercises during warm-up has an advantage over their use during the cool down in improving the eccentric maximum torque and eccentric hamstring muscle to concentric quadriceps ratio. Peterson et al. (2011) reported

that the addition of eccentric hamstring exercise decreased the rate of overall, new, and recurrent acute hamstring injuries in male professional and amateur soccer players. Elerian et al. (2019) also found that adding Nordic exercise as a pre-training reduces all hamstring injuries.

Finally, the resisted sprint exercises are used by few coaches. This may be due to the lack of the necessary equipment (Souidi and Cheriet, 2021), which is in line with the coaches' responses regarding the equipment availability in our study. However, according to McCall et al. (2020) resisted sprint exercises are somewhat to very effective for muscle injury prevention.

Conclusion

To the best of our knowledge, this study is the first to investigate the use of injury prevention exercises in amateur Algerian soccer teams. Most of the teams did not rely on the FIFA 11+ program, and they often used activation and coordination exercises, dynamic stretching and agility exercises. This may be due to the ease of application, especially during warm-up. It was also found that they sometimes use sprint and high-speed running, eccentric, isometric, core, multi-joint, and single leg strength and stability exercises, vertical plyometric, horizontal plyometric, and static stretching. On the other hand, they rarely rely on eccentric exercises, although they are among the most effective exercises for preventing injury.

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Disclosure of interest

All contributing authors declare that they have no conflicts of interest relevant to the content of this study.

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Journal of Anthropology of Sport and Physical Education

ORIGINAL SCIENTIFIC PAPER

Body composition is related to motor abilities of female volleyball players

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Abstract

Success in volleyball certainly depends on the morphological characteristics of the volleyball player, while no technical element can be properly performed without adequate motor abilities. Most of the previous researches only studied the body composition of volleyball players or the researches were conducted on volleyball players in the elite level of the competition. In this regard, the aim of this research was to determine the relationship between body composition and motor abilities in female volleyball players of lower level competition. The sample of respondents consisted of female volleyball players of the women's voleyball club "Student" from Niš who play in the second league "Istok" with an average chronological age of 21.4 ± 2.95 years, who trained volleyball for an average of 10 ± 2.73 years. First, the subjects' body composition parameters were measured (body height, body mass, BMI, fat percentage, muscle percentage), followed by agility tests (Agility T-test, Illinois, Change of direction and acceleration Test (CODAT)), speed (sprint at 10m, 20m and 30m), and explosive strength (Counter Movement Jump (CMJ), Counter Movement Jump With Arm Swing (CMJwas), Squat Jump (SJ)). Based on the obtained results, it could be concluded that there was a statistically significant correlation between body composition parameters and motor abilities of volleyball players in the area of explosive strength and agility. Female volleyball players who had lower body mass and body height achieved better results on explosive strength tests, while volleyball players who had lower body fat and muscle mass % achieved better results on agility tests.

Keywords: *volleyball, body composition, explosive strength, agility, speed*

Introduction

Volleyball is a specific sport that is played over a net where there is no direct contact with the opponent. It represents top technique, strategy and tactics, requires a certain speed of movement, and attracts all groups of participants and spectators (Janković, & Marelić, 1995). As a complex sports branch, volleyball abounds in different motor forms. It is defined as a "polystructural complex sport" in which players demonstrate technique, tactics, motor skills and abilities in order to achieve certain results and achieve success (Janković, & Marelić, 1995). Motor abilities (coordination, explosive power, agility, speed) are one of the factors that certainly have a high coefficient of influence on the quality performance of volleyball players (Magill, 2007).

Success in volleyball certainly depends on the morphological characteristics of the volleyball player, where the basic ones are body height and mass, which are valued considering the current age of the volleyball player (Marelić, Đurković, & Rešetar, 2008). In every sports activity, even in volleyball, no technical element can be properly performed without adequate motor skills and abilities, which cannot be fully expressed without a rational technique of performing movements (Bokan, 2009). The motor abilities that define volleyball players are explosive power in jumps and speed in performing fast, multidirectional movements (agility) (Ciccarone, Croisier, Fontani, Martelli, Albert, et al, 2008). In addition to high technical and tactical skills, the development of motor skills and abilities, as well as appropriate body composition is necessary in volleyball. It has been found

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that success in volleyball is directly related to explosive power of the lower extremities, speed, and a low percentage of body fat (Şimşek, Ertan, Göktepe, & Yazıcıoğlu, 2007; Koç, & Aslan, 2010; Çon, Akyol, Tural, & Taşmektepligil, 2012).

The identification of specific body characteristics that can contribute to success in sports, as well as possible structural differences between athletes in different sports, has been the subject of great interest among sports scientists and coaches (Zaccagni, & Gualdi-Russo, 1996; Duncan, Woodfield, & al-Nakeeb, 2006). Also, the importance of anthropometric characteristics and its influence on motor abilities, volleyball technical skills and psychophysiological characteristics was studied in female volleyball players aged 13-16 years (Stamm 2003; 2006). Body composition determined 42-89% of the results of motor abilities tests, up to 32% of volleyball technical skills tests and up to 43% of psychophysiological tests. Furthermore, there are many studies that compare only the body composition of volleyball players with players of other sports (Bayios, et al., 2006), from other countries (Ayan, et al., 2012; Cabral, et al., 2008; Duncan, et al. 2006; Milic et al., 2012), and at different levels of competition and playing positions (Carvajal, et al., 2012; Gualdi-Russo, & Zaccagni, 2001; Malousaris, et al., 2008). In most cases, previous studies has dealt only with the body composition of female volleyball players, or the studies were conducted on female volleyball players in the elite level of competition.

Therefore, the aim of this study was to determine the correlation between body composition and motor skills in volleyball players of a lower level of competition.

Methods

The sample of respondents

Fifteen volleyball players of the women's volleyball club "Student" from Niš, who play in the second league "Istok", with an average chronological age of 21.4 ± 2.95 years, who has been training volleyball for an average of 10 ± 2.73 years, participated in this study. Before testing, all respondents were familiarized with the protocol and gave voluntary consent to participate in the study.

Testing procedure

The testing was carried out in the evening hours in the hall intended for volleyball. First, there was a 15-minute warm-up, which consisted of various movement exercises and exercises specific to one volleyball training session, in order for the respondents to prepare their body for the tests.

Body height was measured by anthropometry according to Martin GPM 101 (GPM GmbH Switzerland) with an accuracy of 0.1 cm. The respondents stood with their backs resting on the anthropometer, maximally stretched with their heels together, the handle of the anthropometer was placed on the highest point of the crown and the body height was read. (Madić, Nikolić, & Stojiljković, 2015). Then, the respondents' body mass, body mass index, fat percentage, muscle percentage and daily metabolism were measured using bioelectrical impedance Omron BF511 (Kyoto, Japan) with an accuracy of 0.1 kg. The respondents stood barefoot on the instrument with their arms in front of them at shoulder height holding the bioelectrical impedances.

Optojump photoelectric cells were used to evaluate explosive power. The respondents performed three static tests to assess explosive power: Squat Jump (SJ), Counter Movement Jump (CMJ) and Counter Movement Jump With Arm Swing (CMJwas). The SJ test is performed with the hands fixed on the hips while the starting position is a half-squat from which the maximum vertical jump is performed. The CMJ test is also performed with the arms fixed on the hips while the respondent moves from an upright position to a semi-squat position after which she performs a maximal vertical jump, the CMJwas the same starting position as the CMJ except that the respondent also uses arm swing (Madić, Nikolić, & Stojiljković, 2015).

The respondents' running speed was tested using Witty photocell gates (Microgate, Italy) with an accuracy of 0.01s (Madić, Nikolić, & Stojiljković, 2015). The test subjects had the task of running a given section from a high start, at the signal of the meter, in the shortest possible time interval. Witty photocell gates were placed at 5, 10 and 20 meters, which displayed information about the passing times.

For the assessment of agility, Witty photocell gates (Microgate, Italy) were also used, which were placed at the start and/or finish in all 3 tests.: Agility T-test, Illinois agility test and Change of direction and acceleration Test (CODAT). In the Agility T-test, the cones are placed in the shape of the letter T, where the distance from the start to the first cone is 9.14m, while the side cones are 4.57m apart. The test subjects had the task of running in a straight line to the first cone and touching it, then with a lateral movement step-by-step run to the left cone which they touch, then with the same step-step to the right side cone which they also touch, return with the same type of movement to the central cone which they touch and finish the test by going backwards to the starting position (Madić, Nikolić, & Stojiljković, 2015). The Illinois agility test involves an area 10m long and 5m wide, where cones were placed in the middle at a distance of 3.33m. Test respondents start at the lower left cone. At the meter's signal, they run to the upper left cone, go around it, then return to the lower center cone and begin a slalom movement between the center cones in both directions. After exiting the figure eight, the subjects run to the upper right cone, go around it and finish the test at the lower right cone (Madić, Nikolić, & Stojiljković, 2015). In the CODAT test, the respondents ran a sprint for 5m, then a zigzag sprint for 3m each, which is performed at angles of 45° and 90°, and finished the test with a sprint for the remaining 10m (Lockie, Schultz, Callaghan, Jeffriess, & Berry, 2013).

Statistical data processing

Statistical data processing was done using the IBM SPSS Statistics 20 program. Since the normality of the data was confirmed by the Kolmogorov-Smirnov test, we used Pearson's correlation analysis to determine the correlation between body composition and motor abilities of female volleyball players. The correlation coefficient was presented as follows: trivial ($0 < r < 0.1$), small ($0.1 < r < 0.3$), moderate ($0.3 < r < 0.5$), large ($0.5 < r < 0.7$), very large ($0.7 < r < 0.9$) and almost perfect ($0.9 < r < 1$).

Results

Descriptive parameters of body composition and motor abilities, as well as the normality of data distribution are shown in Table 1. The average height of volleyball players was 176.66 ± 7.19cm, while the average body mass was 65.70 ± 7.44kg. The average percentage of fat was 27.24 ± 4.69%, and the average percentage of muscle mass was 31.19 ± 2.76%. BMI is categorized according to World Health Organization data: under 18.5 kg/m2 (underweight); from 18.5 - 24.9 kg/m2 (normal body mass); from 25.0 to 29.9 kg/m2 (overweight) and above 30.0 kg/m2 (obesity) (WHO, 2000). Given that the average BMI was 20.93 ± 1.86, it can be concluded that the volleyball players had normal body mass.

Detailed presentation of the correlation between body composition and motor abilities of female volleyball players is pre-

Table 1. Descriptive statistics and normality of data distribution

	Mean ± Std. Dev.	K-S (Sig.)
BH (cm)	176.66 ± 7.19	0.640
BM(kg)	65.70 ± 7.44	0.950
BMI	20.93 ± 1.86	0.672
BF%	27.24 ± 4.69	0.865
Muscle (%)	31.19 ± 2.76	0.904
CMJ	27.50 ± 3.53	0.661
CMJwAS	31.67 ± 3.90	0.989
SJ	26.94 ± 3.83	0.643
5m	1.29 ± 0.109	0.986
10m	2.16 ± 0.13	0.986
20m	3.76 ± 0.18	0.945
Ilinois	18.07 ± 0.67	0.916
T test	11.62 ± 0.89	0.958
CODAT	6.34 ± 0.48	0.960

Legend: K-S (Sig.) – Kolmogorov-Smirnov test; BH (cm) – body height; BM (kg) – body mass; BMI – body mass index; BF (%) – percentage of body fat; Muscle (%) - muscle percentage; CMJ – country movement jump; CMJwAS – country movement jump with arm swing preparation; SJ – squat jump; 5m – sprint for 5 meters; 10m – sprint for 10 meters; 20m – sprint for 20 meters; Illinois - agility test; T-test – test for assessing agility; CODAT - change of direction and acceleration test

sented in Table 2.

Based on the Pearson's correlation analysis, shown in Table 2, it could be concluded that there was a statistically significant correlation between body composition parameters and motor abilities of female volleyball players in the area of explosive strength and agility.

Table 2. Results of Pearson's correlation analysis.

	CMJ	CMJwas	SJ	5m	10m	20m	Illinois	T-test	CODAT
BH (cm)	0.272	0.044	0.016	0.263	0.120	0.106	0.427	0.055	0.445
BW (kg)	0.144	0.027	0.041	0.620	0.443	0.774	0.753	0.920	0.531
BMI	0.717	0.628	0.964	0.668	0.554	0.247	0.747	0.094	0.155
BF%	0.346	0.205	0.437	0.710	0.795	0.499	0.679	0.048	0.015
Muscle (%)	0.469	0.258	0.401	0.619	0.696	0.441	0.694	0.025	0.017

Legend: K-S (Sig.) – Kolmogorov-Smirnov test; BH (cm) – body height; BW (kg) – body weight; BMI – body mass index; BF (%) – percentage of body fat; Muscle (%) - muscle percentage; CMJ – country movement jump; CMJwas – country movement jump with arm swing preparation; SJ – squat jump; 5m – sprint for 5 meters; 10m – sprint for 10 meters; 20m – sprint for 20 meters; Illinois - agility test; T-test – test for assessing agility; CODAT - change of direction and acceleration test

Discussion

There is clear scientific evidence of a strong correlation between body composition and motor abilities in athletes. In addition to high technical and tactical skills, the development of motor skills and abilities, as well as appropriate body composition is necessary in volleyball. Success in volleyball has been found to be directly related to lower extremity explosive power, speed, and low body fat percentage (Şimşek et al., 2007; Koç, & Aslan, 2010; Çon et al., 2012). In this regard, the aim of this research was to evaluate the relationship between body composition and motor abilities of female volleyball players.

Based on the results shown in Table 2, it can be seen that there was a statistically significant correlation between body composition parameters and motor abilities of female volleyball players in the area of explosive strength and agility. A positive correlation of body composition and motor abilities was observed between the following variables: body height (BH) and body mass (BW) were positively related to explosive power (CMJwAS, SJ), while body fat percentage (BF%) and muscle mass percentage were also positively related to agility (T-test, CODAT). The results of this study were consistent with the results of studies that had the same subject. Namely, a large number of studies (Aslan, Büyükdere, Köklü, Özkan, & Özdemir, 2011; Şimşek et al., 2007; Almuzaini, 2007; Günay, Erol, & Savaş, 1994; Acar, Eler, 2019) found a positive correlation between variables of body composition and motor abilities of volleyball players. Also, there are data that establish a positive correlation between body composition and motor abilities in other athletes (Moncef, Said, Olfa, & Dagbaji, 2012; Copić, Dopsaj, Ivanović, Nešić, & Jarić, 2014). Białoskórska et al. (2016) found a significant correlation between body composition and explosive power in a similar sample, which was also noted in the study (Silvestre, West, Maresh, & Kraemer, 2006).

Female volleyball players who had lower BM and BH achieved better results on explosive strength tests, while volleyball players who had lower BF% and percentage of muscle mass achieved better results on agility tests. Finally, the results of the current study were in accordance with the previous literature that studies the given topic, thus we suggest that there is a statistically significant correlation between body composition parameters and motor abilities of female volleyball players.

Conclusion

There is a clear scientific evidence of a strong correlation between body composition and motor abilities in female volleyball players. Motor abilities and body composition have an impact on the success of the sports performance. A positive correlation of body composition and motor abilities was observed in BH and BM variables with explosive power, while BF% and muscle mass percentage were positively related to agility. Our results indicate that there is a statistically significant relationship between body composition parameters and motor abilities of female volleyball players.

Limitation of the study

This study has potential limitations. The first limitation is the small sample size. Therefore, it is desirable to conduct such research with a larger sample of respondents. Another limitation is the number of measuring instruments (tests) that were used in the assessment of the domain of motor abilities. Namely, it is recommended to use a larger number of tests of motor abilities, including tests for assessment of motor skills for conditions specific to the game of volleyball.

Conflict of interest

The authors declare that there is no conflict of interest.

Future research

For future research, it is recommended to use a larger number of motor ability tests and aslo motor skills test that are closer to the conditions specific for the vollyeball game. Also, it is desirable to have a larger sample of respondents.

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ORIGINAL SCIENTIFIC PAPER

Body Composition And Motor Abilities Of Young Football Players

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Abstract

The aim of this study was to explore the correlation between body composition and motor abilities of young football players. The sample of respondents consisted of 18 football players with a mean chronological age of 14.9 ± 0.28 and with a sports experience of 7.83 ± 2.07 years. The monitored variables of body composition were: body height, body mass, muscle percentage, fat percentage and body mass index. Subsequently, the assessment of motor abilities was carried out by the following tests: speed (10, 20 and 30m sprint), agility (Slalom, Agility T-test and Illinois) and explosive power (Counter Movement Jump, Counter Movement Jump With Arm Swing and Squat Jump). Results indicated that there was a statistically significant positive correlation between body composition and motor abilities of football players. Therefore, it could be concluded that physical preparation together with good monitoring of body composition parameters could lead to the achievement of maximum sports performance.

Keywords: *speed, agility, explosive power, football, anthropometric characteristics*

Introduction

Football is a semi-structured team sport with very fast and dynamic characteristics which contains cyclic and acyclic movement with dynamic and complex kinesiology activities (Sermaxhaj, Popovic, Bjelica, Gardasevic, & Arifi, 2017). Monitoring of the anthropological and individual characteristics of the players as well as the realization of an adequate training process is necessary in order to achieve top success in sports (Gardasevic & Bjelica, 2020). Unfortunately, the focus is on improving physical preparation and less importance is given to body composition (Triki et al., 2012), and a serious approach to the improvement of these components leads to a good technical-tactical preparation of football players (Chamari et al., 2004). Monitoring of body composition and anthropological characteristics is very important because they are a prerequisite for improving motor abilities as well as for achieving maximum success in sports (Reilly, Bangsbo, & Franks, 2000; Gomes, Ribeiro, & Soares, 2005). It has been shown that higher values of body mass, body mass index (BMI) and fat percentage have a negative effect on motor abilities (Gil, Gil, Ruiz, Irazusta, & Irazusta, 2007), while lower values of these parameters lead to better sprint, acceleration, agility and jumping ability (Dodd & Newans, 2018).

There are some studies that have dealt with the issue of the relationship between body composition and motor abilities of football players (Atakan, Unver, Demirci, Bulut, & Turnagol, 2017; Leão et al., 2022; Wong, Chamari, Dellal, & Wisløff, 2009). Furthermore, higher values of body composition parameters such as body mass, BMI and fat percentage have a negative impact on the performance of explosive power, agility and speed. On the other hand, the percentage of muscles can have a positive influence on the results of these motor abilities (Gardasevic, Bjelica, Corluka, & Vasiljevic, 2019).

Identifying ideal values of the body composition is very important for athletes in order to perform motor skills at the best possible level. It is especially important to monitor the progress of these parameters of younger football players because they need to be prepared for achieving sports success. Therefore, the aim of this study was to determine the correlation between body composition and motor abilities of young football players.

Method

The sample of respondents

For the realization of this study, the sample of respondents consisted of 18 football players with a mean chronological age of 14.9 ± 0.28 years, with sports experience of 7.83 ± 2.07 years. The

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football players were healthy during the testing and were familiar with the tests before the testing began and gave their consent to participate in it.

Testing Procedure

Testing of motor abilities and measurement of the anthropological characteristics of the respondents were on an open auxiliary football field. The respondents were warmed up after the anthropological characteristics were taken. Warm up protocol consisted of running around the field with a change of direction and acceleration, static and dynamic stretching exercises in order to prepare as efficiently as possible for the motor abilities tests. Body height was measured by Martin's anthropometer GPM 101 (GPM GmbH Switzerland) with an accuracy of 0.1 cm, while body mass, muscle and fat percentage and body mass index were determined using an Omron BF511 bioelectrical impedance (Omron Healthcare Co, Kyoto, Japan) with an accuracy of 0.1 kg. Reliability and validity of the instrument have been previously reported by Dehghan & Merchant (2008).

The speed test consisted of 10, 20 and 30 meter sprints. Witty photocell gates (Microgate, Italy) with an accuracy of 0.01s were used to measure transit times on these sections. The respondents were behind the starting line in a high start position. They were supposed to run the given sections in the shortest possible time at the signal of the meter.

Agility assessment consisted of the following tests: Slalom, Agility T-test and Illinois. Witty photocell gates (Microgate, Italy) were also used in the realization of these tests. In the slalom test, the respondent was in a high start position behind the starting line while the task was to run between the cones. There were five cones in total. The first cone was 1m away from the starting line, while the distance between the other cones was 2m. The respondent ran with a change of direction from right to left, reaching the last cone and making a 180° turn and returning along the same path between the cones. Reliability and validity of this test was reported by Sporis, Jukic, Milanovic, & Vucetic, (2010). The Agility T-test was carried out by having the respondents in a high start position behind the starting line. At the signal of the meter, they run in a straight line to the placed cone which is 9.14m away, after touching it, they need to use the stepping technique to go to the side cone which is 4.57m away, touch it, then also with a stepping technique to the second side cone, which is at a distance of 9.14m, touch the cone, then with a stepping technique to the central cone, which is also touched. Finally, they were required to complete the last 9.14m by running backwards until they crossed the finish line. Reliability and validity of this test was previously reported by Pauola, Madola, Garhammer, Lacourse, & Rozenek, (2000). For the Illinois test, an area 10m long and 5m wide was required, and cones were placed in the middle of that area at a distance of 3.33m from each other. The respondents were behind the starting line in a standing position, where they started running at the signal of the meters. First, they ran a straight section to the cone located 10m from the start line, go around the cone and run diagonally to the central cones that cross the slalom, then run diagonally to the cone, go around it and run across the 10m section to the finish line. Reliability and validity of this test was shown by Hachan et al., (2013).

The following tests were used to assess the explosive power: Counter Movement Jump (CMJ), Counter Movement Jump With Arm Swing (CMJwAS) and Squat Jump (SJ). Optojump photoelectric cells were used, and its validity and reliability was shown by Glatthor et al., (2011). The CMJ required respondents to move from an upright shoulder-width stance with their arms fixed on their hips to a half-squat and perform a vertical jump. The procedure for realization of CMJwAS was the same as for CMJ. The only difference was that respondents had arm swing during the jump. The starting position for SJ was a half-squat with fixed arms on the hips, and from that position respondents performed a vertical jump. Reliability and validity of these tests was previously reportedn by Markovic, Dizdar, Jukic, & Cardinale, (2004).

Statistical data processing

The IBM SPSS Statistics 20 program was used for statistical data processing. Descriptive statistics of monitored variables were presented and the normality of data distribution was examined by the Kolmogorov-Smirnov test. Pearson's correlation analysis was used to determine the correlation between body composition and motor abilities of young football players. The correlation coefficient was presented accordning to Hopkins, Marshall, Batterham, & Hanin, (2009): trivial ($0 < r < 0.1$), small ($0.1 < r < 0.3$), moderate ($0.3 < r < 0.5$), large ($0.5 < r < 0.7$), very large ($0.7 < r < 0.9$) and almost perfect ($0.9 < r < 1$).

Table 1. Results of descriptive statistics and Kolmogorov-Smirnov test of monitored variables.

	Mean ± Std. Deviation	One-Sample Kolmogorov-Smirnov Test
BH (cm)	171.73 ± 8.54	0.680
BM (kg)	59.75 ± 9.89	0.633
BMI (kg/m2)	20.13 ± 2.23	0.969
fat (%)	10.68 ± 2.78	0.930
muscle (%)	41.95 ± 1.50	0.487
10m	1.90 ± 0.12	0.995
20m	3.24 ± 0.20	0.836
30m	4.49 ± 0.27	0.568
Slalom	7.65 ± 0.39	0.769
T-test	10.26 ± 0.68	0.626
Illinois	16.69 ± 0.57	0.611
CMJ	28.48 ± 3.44	0.876
CMJwAS	36.27 ± 4.67	0.918
SJ	26.65 ± 3.76	0.995

Legend: BH – body height; BM – body mass; BMI – body mass index; fat - fat percentage; muscle - muscle percentage; 10m – 10 meter sprint; 20m – 20 meter sprint; 30m – 10 meter sprint; Slalom – agility test; T-test – agility test; Illinois – agility test; CMJ – Counter Movement Jump; CMJwAS – Counter Movement Jump With Arm Swing; SJ – Squat Jump.

Results

Kolmogorov-Smirnov test results, mean and standard deviation of body composition parameters (body height, body mass, body mass index, fat percentage and muscle percentage) and results of motor abilities (10, 20 and 30m sprint, Slalom, Agility T-test, Illinois, Counter Movement Jump, Counter Movement Jump With Arm Swing and Squat Jump) were shown in Table 1.

The results of Pearson's correlation analysis between body composition and motor abilities of football players were presented in Table 2.

Table 2. Results of Pearson's correlation analysis.

	10m	20m	30m	Slalom	T-test	Illinois	CMJ	CMJwAS	SJ
BH (cm)	-0.109	-0.260	-0.354	0.570†	0.089	-0.158	0.132	0.225	0.221
BM (kg)	-0.222	-0.445	-0.542†	0.315	-0.209	-0.363	0.418	0.513†	0.369
BMI (kg/m2)	-0.292	-0.518†	-0.593†	0.000	-0.405	-0.463	0.567†	0.613†	0.418
fat (%)	0.063	-0.007	-0.040	0.170	0.032	0.025	-0.106	0.232	-0.201
muscle (%)	-0.028	-0.086	-0.142	0.123	0.179	-0.109	0.106	-0.028	0.248

Legend: † - statistical significance ($p < 0.05$); BH – body height; BM – body mass; BMI – body mass index; fat - fat percentage; muscle - muscle percentage; 10m – 10 meter sprint; 20m – 20 meter sprint; 30m – 30 meter sprint; Slalom - agility test; T-test – agility test; Illinois – agility test; CMJ – Counter Movement Jump; CMJwAS – Counter Movement Jump With Arm Swing; SJ – Squat Jump.

Results of Pearson's correlation analysis indicated that there was a statistically significant positive moderate to large correlation between body composition and motor abilities of young football players. Body height had a statistically significant correlation with the slalom agility test (r=0.570, p=0.013). Also, body mass had a statistically significant correlation with CMJwAS (r=0.513, p=0.030) and 30 meter sprint (r=-0.542, p=0.020). Finally, a statistically significant correlation was found between BMI and the CMJ (r=0.567, p=0.014), CMJwAS (r=0.613, p=0.007), 20 meter sprint (r=-0.518, p=0.028) and 30 meter sprint (r=-0.593, p=0.009) tests.

Discussion

The aim of this study was to explore the correlation between body composition and motor abilities of young football players. Analysis of the results indicated that there was a statistically significant correlation between certain parameters of body composition (body height, body mass, BMI, fat and muscle percentage) with motor abilities (speed (10, 20 and 30 meter sprint), agility (slalom, T-test and illinois) and explosive power (CMJ, CMJwAS and SJ)).

Speaking of body height and mass, body height had a statistically significant positive correlation with the results of the slalom test. More precisely, it could be concluded that taller football players passed this agility test more efficiently than shorter ones. Body mass had a statistically significant positive correlation with the results of the 30 meter sprint and CMJwAS. This result of the analysis stems from the fact that football players had a much higher percentage of muscle than the percentage of fat in their body. Furthermore, it could be suggested that football players who had a higher body mass also had a higher percentage of muscles and therefore better results in these motor abilities tests. Gardasevic, Bjelica, Corluka, & Vasiljevic, (2019) had similar results. Namely, it could be concluded that higher values of body mass could lead to a positive influence on motor abilities if there was a higher percentage of muscles in the body. It is recommended that football players reduce the percentage of fat and increase the percentage of muscles in the body in order to achieve the best possible sports success.

The results of the study indicated that BMI had a statistically significant positive correlation with explosive power (CMJ and CMJwAS) as well as with speed (20 and 30 meter sprint). This indicated that higher BMI values led to higher vertical jump and faster running times in sprint. Wong, Chamari, Dellal, & Wisløff, (2009) came to a different result because the football players who made up their sample of respondents had a higher percentage of fat than percentage of muscle, which greatly affected BMI. However, it should be emphasized that BMI is not a reliable indicator, since it can not distinguish muscle mass from fat mass. On the other hand, Leão et al., (2022), found in their study a small positive correlation between BMI and explosive power. It is recommended that monitoring BMI can influence speed and explosive power.

The limitation of the study would be reflected in the small number of sample respondents who could participate in the testing. Also, the testing was carried out immediately after the end of the competitive season. Therefore, it is assumed that if the testing was done before the start of the competition season, the motor abilities of the respondents could be at a more enviable level. Because of all the above, the results of this study cannot be generalized and cannot be applied to the entire population.

Conclusion

Morphological, physiological and motor characteristics play an important role in achieving sports results. Based on the analysis of the results of this study, it has been shown that body composition parameters have a statistically significant positive correlation with speed, agility and explosive power. Identifying the ideal body composition of a football player would have a great impact in sports science. The results of the study can be useful to coaches and other experts in the field of sports, within the training program, as well as in the better guidance of athletes.

Conflict of interest

The authors declare that there is no conflict of interest.

Future research

For future studies, it is desirable to have a larger sample of respondents as well as a larger number of motor ability tests. In this way, more accurate correlation results of body composition and motor abilities could be obtained.

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ORIGINAL SCIENTIFIC PAPER

Impact of residential status on sports activity, anthropometric characteristics and motor abilities of adolescents

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Abstract

The world's leading health institutions warn that adolescents do not meet the minimum level of physical activity necessary for the proper physical development of young people, which is considered one of the main problems of public health. In addition to personal preference, environmental and cultural factors play an important role in the involvement of young people in sports. This study aimed to examine potential differences in involvement in sports, anthropometric characteristics and motor abilities, in adolescents of different residential statuses. The sample included 83 adolescents, of whom 45 (54.2%, 13.51±0.55 yrs) were from urban areas and 38 (45%, 13.45±0.50 yrs) were from rural areas in the Belgrade region. Surveying detected their involvement in sports, and anthropometric characteristics were assessed through body height (BH) body mass (BM), body mass index (BMI), and motor abilities through explosive strength of lower and upper extremities and agility. A Mann-Whitney U test has shown that place of residency impacts involvement in sports and motor abilities, while there was no impact on anthropometric characteristics. Cohen's criteria (r) detected the level of impact. Adolescents from urban areas are more involved at sports and have better motor abilities. There is no difference in anthropometric characteristics. Considering the relatively small sample of respondents and variables assessed, the obtained results can hardly be generalized. However, this does not diminish the importance of the present study which examined the urban-rural state of sports activity, anthropometric characteristics and motor abilities of adolescents in Serbia, thus making an important contribution to this field.

Keywords: *urban-rural differences, adolescent, physical fitness, motor abilities, anthropometric characteristics*

Introduction

The global goals of the world health organizations highlight normal growth as the best indicator of children's physical health, with proper growth and development of physical competencies being a multidimensional determinant of physical, psychological, mental, cognitive, and social well-being. Adolescence is characterized by important inextricably linked, and coordinated physiological and morphological transformations conditioned by genetic (Gajdos, Henderson, Hirschhorn, & Palmert, 2010) and paragenetic factors, whereby motor abilities and skills are mostly developed through physical activity and exercise (Brown, Patel, & Darmawan, 2017).

Adolescence is considered the healthiest period of life, in which motor abilities, primarily strength, speed, and endurance, as well as many cognitive abilities, reach their peaks (Kuzman, 2009). However, the world's leading health institutions believe that adolescents do not meet the minimum level of physical activity (CDC, 2003), which is necessary for the proper physical development of young people, and this is considered one of the main public health problems (Rosamond, et al., 2007).

The habit of exercise and physical activities acquired during the school period is retained in the later periods of life (Paavola, Vartiainen, & Haukkala, 2004), whereby during the period of adoles-

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cence social elements of the environment can influence the biological potential of pubertal development (Euling, Selevan, Pescovitz, & Skakkebaek, 2008; Vasic et al., 2012). Environmental factors, personal preferences, and the cultural environment play an important role in youth involvement in sports (Seabra, Mendonça, Thomis, Anjos, & Maia, 2008; Stalsberg, & Pedersen, 2010; Lämmle, Worth, & Bos, 2012; Li, Kearney, Keane, Harrington, & Fitzgerald, 2017; Olson, March, Brownlow, Biddle, & Ireland, 2019).

A large number of studies examining sports activity in urban and rural environments included the youth population. The largest number of studies is focused on researching the relationship and influence of place of residence on involvement in sports (Li et al., 2017; Olson et al., 2019), physical characteristics, and motor skills of young people (Ujevic, Sporis, Milanovic, Pantelic, & Neljak, 2013; Chillón, Ortega, Ferrando, & Casajus, 2011; Nikolic, Kocic, Beric, Cvetkovic, & Krzalic, 2015). Some authors suggest that there are differences in motor skills between children from urban and rural areas (Joens-Matre et al., 2008; Gadzic & Vuckovic, 2012) pointing to the better results of urban youth (Ujevic et al., 2013; Andrade et al., 2014) while others point out that rural students are more competitive (Wang, Wu, & Chang, 2013; Rodrigues et al., 2014; Li et al., 2017). Some studies indicate that there is no significant difference in BMI between urban and rural populations, while there is a moderate difference in handgrip strength and running speed favoring rural populations (Tishukaj et al., 2017). Lammle et al. (2012) state that there is no significant difference in the level of physical activity and physical condition between respondents from urban and rural areas (Lammle et al., 2012).

Since the results are not consistent, and only a small number of studies have examined the residential status of adolescents in our country, there is a need for such research. In this regard, this study aimed to examine potential differences in involvement in sports, anthropometry, and motor capabilities of adolescents of different residential statuses.

Methods

The Sample of Participants

A total of 83 healthy adolescents participated in this transversal study. The sample was divided by the location of the registered residence into two groups: urban and rural. The urban group consisted of 45 (54.2%, 13.51±0.55 yrs) adolescents residing in the city municipality of Vozdovac (Belgrade) and attending the "Bora Stankovic" elementary school, while the rural group consisted of 38 (45%, 13.45±0.50) adolescents residing in the village of Vranić attending the "Pavle Popovic" elementary school.

The schools gave their consent for the implementation of the research. Students participated in the research process voluntarily and with parental consent, and this research was conducted in accordance with the Helsinki Declaration.

The Sample of Measuring Instruments

The sample of measuring instruments consisted of a survey, anthropometric characteristics, and motor abilities tests. Data on participation in sports were obtained through a survey.

Body height (BH) was measured to the nearest 0.1 cm using a fixed stadiometer (Seca, Leicester, UK) and body mass (BM) was measured to the nearest 0.1 kg with an electronic weighing machine (HD-351, Tanita, Illinois, USA). The standard formula for calculating the body mass index (BMI) was used: BMI = body mass (kg) ÷ body height2 (meters). The measurements were taken according to a predetermined International Biological Program (IBP; Marfell-Jones, Stewart, & de Ridder, 2012).

The following tests were used to assess motor abilities: a standing broad jump (SBJ, cm), which assesses the explosive power of the lower extremities; a medicine ball throwing (MBT, 2 kg) from a sitting position (cm), which assesses the explosive power of the upper extremities; and a 5 x 10 m shuttle run (s) which assess agility.

Statistics

The data obtained were tested using the Kolmogorov-Smirnov test to determine the normality of the data distribution. While the Mann-Whitney U test was used to determine differences between the groups of urban and rural adolescents. Cohen's criterion (r) was used to determine the effect size (Pallant, 2009). The significance level for all statistical analyses was set at $p<0.05$. Data processing was performed using the statistical program SPSS v19.0 (SPSS Inc., Chicago, IL, USA).

Results

Table 1 shows that in both groups of urban and rural adolescents, there are more boys than girls, and this ratio is approximately 58% versus 42%. The average age is about the same. The urban group is more involved in sports than rural adolescents, and in the total sample, the percentage of those involved in sports is lower than the percentage of those who are not involved (48.2%<51.8%).

Table 1. Indicators of residential status, gender, age, and involvement in sports

	Gender		Age	Participation in Sports	
	Boys	Girls	Mean±SD	Yes	No
Urban	26 (57.8%)	19 (42.2%)	13.51±.549	66.7%	33.3%
Rural	22 (57.9%)	16 (42.1%)	13.45±.504	26.3%	73.7%
Total	48 (57.8%)	35 (42.2%)	13.48±.526	48.2%	51.8%

Table 2. Descriptive statistics of physical characteristics and motor abilities

Variables	Urban			Rural			Total		
	Mean±SD	Min.	Max	Mean±SD	Min.	Max	Mean±SD	Min.	Max
Body height	170.66±9.25	153.2	190.8	168.13±6.87	154.0	188.5	169.50±8.29	153.2	190.8
Body mass	60.44±10.39	41.0	92.5	57.85±12.44	39.5	100.0	59.25±11.37	39.5	100.0
BMI	20.74±3.06	15.4	28.8	20.40±3.87	14.4	33.0	20.59±3.45	14.4	33.0
Standing Broad Jump	172.32±27.79	115.0	237.0	156.18±32.59	83.0	215.0	164.93±30.97	83.0	237.0
Medicine ball throwing	370.07±103.37	200.0	679.2	347.01±92.03	145.5	574.8	359.51±98.43	145.5	679.2
Agility 5x10*	14.11±1.31	11.30	17.80	15.24±1.71	12.11	19.38	14.63±1.60	11.30	19.38

*Variable with an opposite metric orientation

Descriptive statistics in terms of anthropometric characteristics and motor abilities is presented in Table 2.

The results of the Kolmogorov-Smirnov test (Table 3) showed that the assumption of normal distribution was violated for most variables, and for this reason, a non-parametric Mann-Whitney U test was performed.

Table 3. Kolmogorov-Smirnov test

	Kolmogorov-Smirnov		
	Statisic	df	Sig
Body height	0.86	83	0.016
Body mass	0.109	83	0.198
BMI	0.115	83	0.008
Standing Broad Jump	0.061	83	0.200
Medicine ball throwing	0.118	83	0.006
Agility 5x10*	0.074	83	0.200

*Variable with an opposite metric orientation

The Mann-Whitney U test (Table 4) has shown that there is no significant difference between urban and rural groups in anthropometric characteristics. On the other hand, a significant difference in motor abilities was identified, namely in SBJ (r=0.25; p=0.024) and 5 x 10 m shuttle run (r=0.34; p=0.002). The size of the impact for SBJ is small, while for 5 x 10 m shuttle run is medium.

Table 4. Urban-rural differences in anthropometric and motor abilities

	Urban	Rural		
	Mean±SD	Mean±SD	Sig	Choen's r
Body height	170.66±9.25	168.13±6.87	0.210	0.1
Body mass	60.44±10.39	57.85±12.44	0.150	0.1
BMI	20.74±3.06	20.40±3.87	0.370	0.1
Standing Broad Jump	172.32±27.79	156.18±32.59	0.024	0.25
Medicine ball throwing	370.07±103.37	347.01±92.03	0.385	0.1
Agility 5x10*	14.11±1.31	15.24±1.71	0.002	0.34

*Variable with an opposite metric orientation.

Discussion

Main findings of this study indicate that adolescents from the urban areas are significantly more involved in sports than those from the rural areas. There are no significant differences between urban and rural groups in terms of anthropometric characteristics, while there is a significant difference in terms of motor abilities. More precisely, adolescents from urban areas have better explosive power of the lower extremities and better agility than the adolescents from rural areas.

In line with our results, a previous study that included 205 children has shown that the environment affects playing sports, where the participation of rural youth is lower (Davi, Harrell, Stewart, & King, 2004). Other studies also reveal a different impact of urbanization on sports participation (Chillon et al., 2011). Lammle et al. (2012) in their study that included 2574 respondents from Germany, indicate that there is no significant difference between urban and rural areas when it comes to the level of physical activity (Lammle et al., 2012). Different levels of urbanization and population density contribute to different access to sports facilities (Reimers et al., 2014) and opportunities to play sports (Parks et al., 2003).

We suggest that twenty-four sports branches and 54 clubs in the territory of the city municipality of Vozdovac provide a better sports offer for young people compared to three sports clubs in two sports in the village of Vranic (SS GO Vozdovac, 2020, GO Barajevo 2020). Adolescents from Vozdovac play 12 sports, with most of them playing basketball (15.6%), while adolescents from Vranic play five sports, with most of them playing football (13.2%). All sports except football are played outside the territory of the village, and the mass participation of rural youth in sports involves traveling outside the village. These facts may indicate the reasons for the existence of a significant difference in the participation of young people in sports. In this line, some authors suggested that the difference in the social structure of the city and the village exposed through socio-economic, infrastructural, cultural, and educational factors, life habits, and the way of spending school and leisure time, has a different effect on the involvement of adolescents in physical activities (Seabra et al., 2008; Stalsberg et al., 2010; Badric, Prskalo, & Kvesic, 2011; Lammle et al., 2012; Li et al., 2017; Olson et al., 2019).

The present study also shows that there is no difference in anthropometric characteristics (BH, BM, and BMI) between urban and rural adolescents, which is in line with previous evidence (Andrade et al., 2014; Zegnal & Koretic, 2017). In contrast, some studies have shown that children from rural areas have lower values of BMI and BH (Gadzic and Vuckovic, 2012), BM and BMI (Chillon et al., 2011), and other anthropometric characteristics (Vasic et al., 2012). We suggest that the different outcome in these studies may be influenced by hereditary factors and eating habits. It is known that higher BMI values can be attributed to inadequate nutrition, biological age, and genetic conditioning (Banjevic et al., 2022).

The results of our research show that adolescents from the urban areas achieved a significantly better result in the explosive strength of the lower extremities than their peers from the rural areas, while the size of the effect is small. These results are consistent with previous research (Gadzic & Vučkovic, 2012; Ujevic et al., 2013; Vang et al., 2013) where respondents from the city also

achieved better results compared to respondents from the countryside on various explosive tests. It should be noted that in some studies, the authors did not find a significant difference between urban and rural adolescents in the explosive strength of the lower extremities (Nikolic et al., 2015; Tisukaj et al., 2017). Differences in the outcome of these studies may be due to different methodological design, different tests used to assess explosive strength of lower extremities as well as different age of the studied population.

In contrast to the lower extremities, there was no difference between the groups in the strength of the upper extremities at the present study. Nikolic et al. (2015) conducted one of the few studies that looked at urban-rural differences in upper limb strength. In this study, a significant difference was achieved in the case of urban children, which was not the case in our study. We suggest that the different outcome may be due to the different age of the studied population, and also the effect of puberty, which may directly impact the levels of strength. Unfortunately, we have no data regarding the puberal stage in which the studied children are. Also, finding no significant difference in the explosive strength of the upper extremities between the groups of subjects could be interpreted by the fact that adolescents from the rural areas, compared to their peers from the urban areas spend most of their time actively outside the home in leisure activities.

When it comes to agility, adolescents from the urban area showed significantly better results than the respondents from the countryside, while the size of the effect was medium. Agility develops with specific training contents and contextually combines explosive strength and speed (Malacko, 2009). The obtained results show that adolescents from the city are more involved in sports and that, at the same time, they achieved significantly better results in the explosive power of the lower extremities and agility.

Additionally, within the sub-sample, 66.7% of the urban population does sports, compared to 26.3% of the rural population. Among respondents from the city, 15.6% play basketball and 8.9% play volleyball, while among adolescents from the countryside, 5.3% play basketball. For basketball and volleyball, the dominant manifestation is the explosive strength and agility. Basketball and volleyball training contents are designed to improve explosive strength and agility (Trunic & Mladenovic, 2015; Lazic, 2016) in order to achieve more advanced sports results. Therefore, we suggest that the type of sports activity and the percentage of adolescents that are practicing that activity, may be the factors that acting together, influenced the differences in motor abilities, as well as their more advanced development in adolescents from urban areas.

Limitations

Some of the limitations of this study are reflected in the relatively small sample and the fact that anthropometric characteristics and motor abilities were assessed with a small number of tests. Additionally, the lack of pubertal stage data may be another limitation. Therefore, the recommendation for further research is to include a larger number of variables and a larger number of respondents with a possibility for pubertal status assessment.

Conclusions

This research showed that urban adolescents were more likely to participate in sports than children from rural areas. The reason for this may be that cities have a greater socio-economic potential, which is why they have a wider range of sports and easier access to sports infrastructure. The findings of the present study indicate that the place of residence does not affect the anthropometric dimensions, while it seems to affect motor abilities. Adolescents from urban areas have better explosive power of the lower extremities and better agility than the adolescents from rural areas. Based on these findings, the necessity of a comprehensive social intervention to improve conditions in rural areas for greater access to sports should be emphasized.

Given the relatively small sample of respondents and variables, the obtained results can hardly be generalized. However, this does not diminish the importance of this study which determined the urban-rural state of sports activity, anthropometric characteristics and motor abilities of adolescents in Serbia, and thereby made an important contribution to this field.

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Conflicts of Interest

Authors declare that there is no conflict of interest.

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Guidelines for Authors

Revised October 2017

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

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

1. UNIFORM REQUIREMENTS

1.1. Overview

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

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

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

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

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

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

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

Type the whole manuscript double-spaced, justified alignment.

Use Times New Roman font, size eleven (11) point.

Number (Arabic numerals) the pages consecutively (centering at the bottom of each page), beginning with the title page as page 1 and ending with the Figure legend page.

Include line numbers (continuous) for the convenience of the reviewers.

Apart from chapter headings and sub-headings avoid any kind of formatting in the main text of the manuscripts.

1.2. Type & Length

JASPE publishes following types of papers:

Original scientific papers are the results of empirically- or theoretically-based scientific research, which employ scientific methods, and which report experimental or observational aspects of anthropology of sport and physical education from five major fields of anthropology: cultural, global, biological, linguistic and medical. Descriptive analyses or data inferences should include rigorous methodological structure as well as sound theory. Your manuscript should include the following sections: Introduction, Methods, Results, and Discussion.

☑Open Submissions ☑Indexed ☑Peer Reviewed

Original scientific papers should be:

- Up to 3000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 30;
- Maximum combined total of 6 Tables/Figures.

Review papers should provide concise in-depth reviews of both established and new areas, based on a critical examination of the literature, analyzing the various approaches to a specific topic in all aspects of anthropology of sport and physical education from five major fields of anthropology: cultural, global, biological, linguistic and medical.

☑Open Submissions ☑Indexed ☑Peer Reviewed

Review papers should be:
- Up to 6000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 100.

Editorials are written or commissioned by the editors, but suggestions for possible topics and authors are welcome. It could be peer reviewed by two reviewers who may be external or by the Editorial Board.

☐Open Submissions ☑Indexed ☑Peer Reviewed

Editorials should be:
- Up to 1000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 10.

Short reports of experimental work, new methods, or a preliminary report can be accepted as two page papers. Your manuscript should include the following sections: Introduction, Methods, Results, and Discussion.

☑Open Submissions ☑Indexed ☑Peer Reviewed

Short reports should be:
- Up to 1500 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 15.

Peer review - fair review provides authors who feel their paper has been unfairly rejected (at any journal) the opportunity to share reviewer comments, explain their concerns, and have their paper reviewed for possible publication in JASPE.

☑Open Submissions ☑Indexed ☐Peer Reviewed

Peer review - fair review should be:
- Up to 1500 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 15.

Invited papers and award papers include invited papers from authors with outstanding scientific credentials. Nomination of invited authors is at the discretion of the JASPE editorial board. JASPE also publishes award papers selected by the scientific committee of the publisher's conferences.

☐Open Submissions ☑Indexed ☐Peer Reviewed

Invited papers and award papers should be:
- Up to 3000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 30;
- Maximum combined total of 6 Tables/Figures.

1.3. Submission

JASPE only accepts electronic submission to the e-mail of the Journal Office: **jaspe@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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S. Nepocatych

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100 Campus Dr.

2525 CB

Elon, NC 27244

United States

E-mail: snepocatych@elon.edu

Word count: 2,946

Word count: 4259

Abstract word count: 211

Number of Tables: 3

2.1.1. Title

Title should be short and informative and the recommended length is no more than 20 words. The title should be in Title Case, written in uppercase and lowercase letters (initial uppercase for all words except articles, conjunctions, short prepositions no longer than four letters etc.) so that first letters of the words in the title are capitalized. Exceptions are words like: "and", "or", "between" etc. The word following a colon (:) or a hyphen (-) in the title is always capitalized.

2.1.2. Type of publication

Authors should suggest the type of their submission.

2.1.3. Running head

Short running title should not exceed 50 characters including spaces.

2.1.4. Authors

The form of an author's name is first name, middle initial(s), and last name. In one line list all authors with full names separated by a comma (and space). Avoid any abbreviations of academic or professional titles. If authors belong to different institutions, following a family name of the author there should be a number in superscript designating affiliation.

2.1.5. Affiliations

Affiliation consists of the name of an institution, department, city, country/territory (in this order) to which the author(s) belong and to which the presented / submitted work should be attributed. List all affiliations (each in a separate line) in the order corresponding to the list of authors. Affiliations must be written in English, so carefully check the official English translation of the names of institutions and departments.

Only if there is more than one affiliation, should a number be given to each affiliation in order of appearance. This number should be written in superscript at the beginning of the line, separated from corresponding affiliation with a space. This number should also be put after corresponding name of the author, in superscript with no space in between.

If an author belongs to more than one institution, all corresponding superscript digits, separated with a comma with no space in between, should be present behind the family name of this author.

In case all authors belong to the same institution affiliation numbering is not needed.

Whenever possible expand your authors' affiliations with departments, or some other, specific and lower levels of organization.

2.1.6. Corresponding author

Corresponding author's name with full postal address in English and e-mail address should appear, after the affiliations. It is preferred that submitted address is institutional and not private. Corresponding author's name should include only initials of the first and middle names separated by a full stop (and a space) and the last name. Postal address should be written in the following line in sentence case. Parts of the address should be separated by a comma instead of a line break. E-mail (if possible) should be placed in the line following the postal address. Author should clearly state whether or not the e-mail should be published.

2.1.7. Manuscript information

All authors are required to provide word count (excluding title page, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References), the Abstract word count, the number of Tables, and the number of Figures.

2.2. Abstract

The second page of the manuscripts should be the abstract and key words. It should be placed on second page of the manuscripts after the standard title written in upper and lower case letters, bold.

Since abstract is independent part of your paper, all abbreviations used in the abstract should also be explained in it. If an abbreviation is used, the term should always be first written in full with the abbreviation in parentheses immediately after it. Abstract should not have any special headings (e.g., Aim, Results…).

Authors should provide up to six key words that capture the main topics of the article. Terms from the Medical Subject Headings (MeSH) list of Index Medicus are recommended to be used.

Key words should be placed on the second page of the manuscript right below the abstract, written in italic. Separate each key word by a comma (and a space). Do not put a full stop after the last key word. *See* example:

Abstract

Results of the analysis of

Key words: *spatial memory, blind, transfer of learning, feedback*

2.3. Main Chapters

Starting from the third page of the manuscripts, it should be the main chapters. Depending on the type of publication main manuscript chapters may vary. The general outline is: Introduction, Methods, Results, Discussion, Acknowledgements (optional), Conflict of Interest (optional), and Title, Author's Affiliations, Abstract and Key words must be in English (for both each chosen language of full paper). However, this scheme may not be suitable for reviews or publications from some areas and authors should then adjust their chapters accordingly but use the general outline as much as possible.

2.3.1. Headings

Main chapter headings: written in bold and in Title Case. *See* example:

- ✓ **Methods**

Sub-headings: written in italic and in normal sentence case. Do not put a full stop or any other sign at the end of the title. Do not create more than one level of sub-heading. *See* example:

- ✓ *Table position of the research football team*

2.3.2 Ethics

When reporting experiments on human subjects, there must be a declaration of Ethics compliance. Inclusion of a statement such as follow in Methods section will be understood by the Editor as authors' affirmation of compliance: "This study was approved in advance by [name of committee and/or its institutional sponsor]. Each participant voluntarily provided written informed consent before participating." Authors that fail to submit an Ethics statement will be asked to resubmit the manuscripts, which may delay publication.

2.3.3 Statistics reporting

JASPE encourages authors to report precise p-values. When possible, quantify findings and present them with appropriate indicators of measurement error or uncertainty (such as confidence intervals). Use normal text (i.e., non-capitalized, non-italic) for statistical term "p".

2.3.4. 'Acknowledgements' and 'Conflict of Interest' (optional)

All contributors who do not meet the criteria for authorship should be listed in the 'Acknowledgements' section. If applicable, in 'Conflict of Interest' section, authors must clearly disclose any grants, financial or material supports, or any sort of technical assistances from an institution, organization, group or an individual that might be perceived as leading to a conflict of interest.

2.4. References

References should be placed on a new page after the standard title written in upper and lower case letters, bold.

All information needed for each type of must be present as specified in guidelines. Authors are solely responsible for accuracy of each reference. Use authoritative source for information such as Web of Science, Medline, or PubMed to check the validity of citations.

2.4.1. References style

JASPE adheres to the American Psychological Association 6th Edition reference style. Check "American Psychological Association. (2009). Concise rules of APA style. American Psychological Association." to ensure the manuscripts conform to this reference style. Authors using EndNote® to organize the references must convert the citations and bibliography to plain text before submission.

2.4.2. Examples for Reference citations

One work by one author
- ✓ In one study (Reilly, 1997), soccer players
- ✓ In the study by Reilly (1997), soccer players
- ✓ In 1997, Reilly's study of soccer players

Works by two authors
- ✓ Duffield and Marino (2007) studied
- ✓ In one study (Duffield & Marino, 2007), soccer players
- ✓ In 2007, Duffield and Marino's study of soccer players

Works by three to five authors: cite all the author names the first time the reference occurs and then subsequently include only the first author followed by et al.
- ✓ First citation: Bangsbo, Iaia, and 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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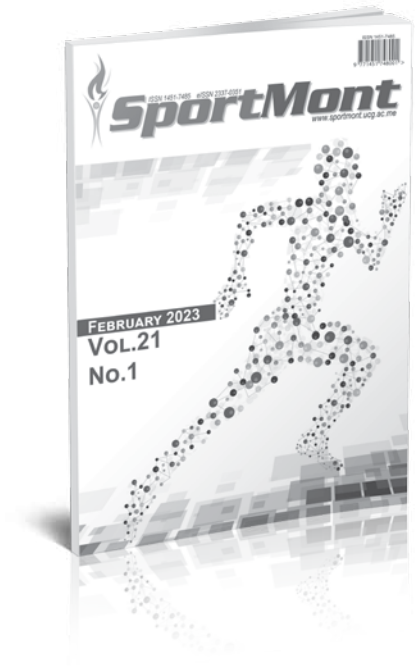

ISSN 1451-7485

Sport Mont Journal (SMJ) is a print (ISSN 1451-7485) and electronic scientific journal (eISSN 2337-0351) aims to present easy access to the scientific knowledge for sport-conscious individuals using contemporary methods. The purpose is to minimize the problems like the delays in publishing process of the articles or to acquire previous issues by drawing advantage from electronic medium. Hence, it provides:

- Open-access and freely accessible online;
- Fast publication time;
- Peer review by expert, practicing researchers;
- Post-publication tools to indicate quality and impact;
- Community-based dialogue on articles;
- Worldwide media coverage.

SMJ is published three times a year, in February, June and October of each year. SMJ publishes original scientific papers, review papers, editorials, short reports, peer review - fair review, as well as invited papers and award papers in the fields of Sports Science and Medicine, as well as it can function as an open discussion forum on significant issues of current interest.

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

Prospective authors should submit manuscripts for consideration in Microsoft Word-compatible format. For more complete descriptions and submission instructions, please access the Guidelines for Authors pages at the SMJ website: http://www.sportmont.ucg.ac.me/?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:

Dusko BJELICA, Editor-in Chief – sportmont@t-com.me
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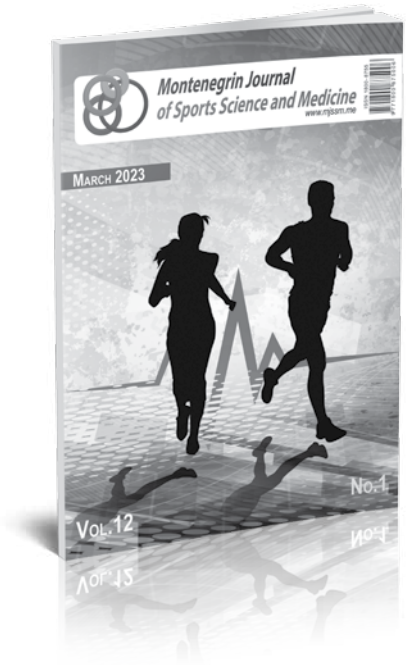
Publication date: Summer issue – June 2023
Autumn issue – October 2023
Winter issue – February 2024

Montenegrin Journal of Sports Science and Medicine

MONTENEGRIN **J**OURNAL
OF **S**PORTS **S**CIENCE
AND **M**EDICINE



ISSN 1800-8755

CALL FOR CONTRIBUTIONS

Montenegrin Journal of Sports Science and Medicine (MJSSM) is a print (ISSN 1800-8755) and electronic scientific journal (eISSN 1800-8763) aims to present easy access to the scientific knowledge for sport-conscious individuals using contemporary methods. The purpose is to minimize the problems like the delays in publishing process of the articles or to acquire previous issues by drawing advantage from electronic medium. Hence, it provides:

- Open-access and freely accessible online;
- Fast publication time;
- Peer review by expert, practicing researchers;
- Post-publication tools to indicate quality and impact;
- Community-based dialogue on articles;
- Worldwide media coverage.

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

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

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Dusko BJELICA, Editor-in Chief – sportmont@t-com.me
Damir SEKULIC, Editor-in Chief – damirsekulic.mjssm@gmail.com

Publication date: Autumn issue – September 2023
Spring issue – March 2024

Montenegrin Sports Academy welcomes you to *Dubrovnik, Croatia*

www.csakademija.me/conference

KEY DATES

- **1st of July 2022, 24:00 CET**
  Abstract submission opening and opening of registration
- **1st of December 2022, 24:00 CET**
  Abstract submission deadline
- **15th of January 2023, 24:00 CET**
  Notification to authors about acceptance
- **1st of February 2023, 24:00 CET**
  Deadline for early-bird registration for presenting authors
- **15th of February 2023, 24:00 CET**
  Deadline for late registration for presenting authors

* CET = Central European Time

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MSA Dubrovnik 2023

20th Annual Scientific Conference of Montenegrin Sports Academy "Sport, Physical Activity and Health: Contemporary Perspectives"

MSA Dubrovnik 2023

20th - 23th April 2023

CONFERENCE VENUE

Hotel Croatia Cavtat, situated across the bay from the historic walls of Dubrovnik, Hotel Croatia Cavtat is a leading five-star resort and conference hotel on the southern part of Adriatic. Hotel Croatia's architecture blends seamlessly with its natural surroundings. Shaded by a pine tree forest, while offering spectacular sea views, all 487 accommodation units feature balconies which overlook the Adriatic Sea or Cavtat Bay. State-of-the-art facilities include numerous gourmet restaurants, a spa centre, and private beaches. Hotel Croatia is ideal for a broader experience of the Dubrovnik Riviera. Suited for business and relaxation alike, Hotel Croatia serves as an excellent base for exploring the city of Dubrovnik and the Dubrovnik Riviera.

WELCOME TO DUBROVNIK

Regardless of whether you are visiting Dubrovnik for the first time or the hundredth, the sense of awe never fails to descend when you set eyes on the beauty of the old town. Indeed it's hard to imagine anyone becoming jaded by the city's white limestone streets, baroque buildings and the endless shimmer of the Adriatic, or failing to be inspired by a walk along the ancient city walls that protected a civilised, sophisticated republic for centuries.

LANGUAGE

The official Conference language is English.

FIRST ANNOUNCEMENT

Dear Friends and Colleagues,

Montenegrin Sports Academy will mark its 20th Anniversary by organising the 20th Annual Scientific Conference during 20.-23. April 2023 in Dubrovnik Croatia. The 20th Anniversary Conference will be held in Hotel Croatia, Cavtat.

Reserve your calendars, let us gather in person after these turbulent times and make our conference even more prestigious. Guarantee for our further prosperity is our international partners and Montenegrin Sports Academy. See you in Dubrovnik next spring!

We look forward to seeing you in spring 2023,

Prof. Duško Bjelica, Conference President

Conference sub-themes include:

Adapted Physical Activity; Anthropology; Architecture and Urbanism; Biochemistry; Biomechanics; Coaching; Economics; Health and Fitness; History; Molecular Biology; Motor Learning; Neuromuscular Physiology; Nutrition; Olympism; Philosophy and Ethics; Physical Education and Pedagogics; Physiology; Physiotherapy; Psychology; Rehabilitation; Sociology; Sport Management and Law; Sport Statistics and Analyses; Sport Technology; Sport Tourism; Sports Medicine and Orthopaedics; Training and Testing; Traumatology; and other Multi- & Interdisciplinary Themes.

Look inside!

Montenegrin Journal of Sports Science and Medicine

Volume 11, 2022, 2 issues per year;
Print ISSN: 1800-8755, Online ISSN: 1800-8763

www.mjssm.me

Sport Mont

Volume 20, 2019, 3 issues per year;
Print ISSN: 1451-7485, Online ISSN: 2337-0351

www.sportmont.ucg.ac.me

Journal of Anthropology of Sport and Physical Education

Volume 6, 2022, 4 issues per year;
Print ISSN: 2636-569X, Online ISSN: 2536-5703

www.jaspe.ac.me

CALL FOR ABSTRACTS

Research scholars and students are invited to present their original work in any of the conference sub-themes. The list of the conference sub-themes is not exhaustive and, therefore, authors should not feel limited by them. Authors can submit their original work in the form of an ABSTRACT, free of charge. An author may submit only one abstract as the first author and two abstracts as the co-author. After undergoing the reviewing process, all authors will be notified about the condition of their submission (accepted or rejected). Presenters (= the first authors) must be registered and have paid registration fees for the conference to secure their oral or poster (not debated) presentation during the conference and the publication in Montenegrin Journal of Sports Science and Medicine that is abstracted/indexed in Emerging Sources Citation Index, SCOPUS and other database, under the condition that the first author has paid registration fee.

CALL FOR PAPERS

Full-length manuscripts may be submitted for publishing in the Sport Mont journal (see at HYPERLINK "http://www.sportmont.ucg.ac.me" www.sportmont.ucg.ac.me), an international peer-reviewed scientific journal, indexed in Scopus, DOAJ, SPORTDiscus, Index Copernicus, ERIH PLUS, et cetera. Full-length paper submission is free of charge but author(s) has to pay additional 50 euros per accepted full-length paper to cover publication costs. Full manuscripts should be submitted for consideration of publication by the 15th of March, 2023 and prepared according to the guidelines for authors.

REGISTRATION FEES

For participants 260 EUR (220 EUR early-bird)
For students 190 EUR (160 EUR early-bird)
For accompanying persons 140 EUR (110 EUR early-bird)

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.

USEFUL CONTACTS

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Sports Science and Medicine Journals

from Montenegrin Sports Academy

We have expanded the quality of our journals considerably over the past years and can now claim to be the market leader in terms of breadth of coverage.

As we continue to increase the quality of our publications across the field, we hope that you will continue to regard MSA journals as authoritative and stimulating sources for your research. We would be delighted to receive your comments and suggestions, mostly due to the reason your proposals are always welcome.

Look Inside!

Sport Mont Journal

Editors-in-Chief: **Dusko Bjelica**, Montenegro; **Zoran Milosevic**, Serbia
Managing Editor: **Borko Katanic**, Montenegro; **Nedim Covic**, Bosnia and Herzegovina

Volume 21, 2023, 3 issues per year; Print ISSN: 1451-7485, Online ISSN: 2337-0351

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www.sportmont.ucg.ac.me

Montenegrin Journal of Sports Science and Medicine

Editors-in-Chief: **Dusko Bjelica**, Montenegro; **Damir Sekulic**, Croatia
Executive Editor: **Selcuk Akpinar**, Turkey
Associate Editors: **Mehmet Uygur**, USA; **Catalina Casaru**, USA; and **Predrag Bozic**, Serbia

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www.mjssm.me


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20th - 23th April 2023,
Dubrovnik - Croatia